SEP 27 1923

Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXVI.—No. 3533] LONDON: FRIDAY EVENING, SEPTEMBER 14, 1923 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Science and Industry in America.

The Hamburg-American Liner Albert Ballin.

Institution of Naval Architects in Holland (No. II).

Electrical Structure of Matter.

Institute of Metals.

Electricity in Mines—No. VIII.

Shipping, Engineering and Machinery Exhibition at Olympia—No. III.

PUBLIC NOTICES

AIR WASHING MACHINES.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 2nd October, 1923, for the SUPPLY and INSTALLATION of TWO AIR WASHING MACHINES, with PUMPS, MOTORS, &c., at the Imperial College of Science, South Kensington.

Drawings, specification, form of contract, schedules, and forms of Tender may be obtained from the CONTRACTS BRANCH, H.M. OFFICE OF WORKS, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Secretary, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3513

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES:—
1. DOG SPIKES.
2. STEAM HAMMER.
Tenders due on the 5th October, 1923.
Tender forms obtainable from above. 3512

Tenders will be Received at the office of the Colonial Secretary in Singapore, S.S., on or before the 30th November, 1923 (due allowance being made for delays in the post), for the following WORKS:—

NEW GENERAL POST OFFICE, SINGAPORE.

Any person applying for a form of Tender must deposit the sum of £10 with the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1.

Drawings, specification, quantities and contract documents may be seen and forms of Tender obtained at the office of the Crown Agents between the hours of 10 a.m. and 4 p.m.

Tenders must be addressed to the COLONIAL SECRETARY, Straits Settlements, Singapore, to reach him by 30th November, 1923. The successful tenderer must undertake to find, if required, security to the amount of 100,000 dollars (Straits), which will be returned when the reserve deducted from certificates amounts to a like sum.

Tenders must be marked "Tender for New General Post Office, Singapore," and must be on the printed form issued by the Crown Agents.

In the event of any person whose Tender has been accepted failing within thirty days from the date of acceptance to enter into the necessary contract or deposit the security required under the contract for its due fulfilment, the sum deposited may be forfeited to the Crown.

Tenders sent to Singapore from overseas must be accompanied by the priced schedule of quantities, forwarded to the Colonial Secretary, Singapore, S.S., in separate sealed packets marked with the name and address of the tenderer. The priced schedule of quantities of the successful tenderer only will be opened for examination; in all other cases the schedules will be returned unopened.

The Government does not bind itself to accept the lowest or any Tender. 3527

Assistant Civil Engineers REQUIRED in Civil Engineer-in-Chief's Department, Admiralty, at H.M. Naval Establishments at home and abroad. Candidates must be corporate members of the Institution of Civil Engineers and not more than 30 years of age. Successful candidates will be on probation for two years, on satisfactory completion of which they will be appointed to the permanent staff, and will then be eligible for promotion to higher grades on the usual conditions.

Commencing salary £300 per annum; the current Civil Service bonus, at present about £106, will be paid in addition.

TEMPORARY ENGINEERING ASSISTANTS REQUIRED in London Office of Civil Engineer-in-Chief's Department, Admiralty, and at Outports. Candidates should have had a good general civil engineering experience and be capable draughtsmen, of between 24 and 30 years of age; if selected, they will be eligible, after one year's service—provided they are satisfactory and otherwise qualified—for the appointment of Assistant Civil Engineer on conditions mentioned above for that grade.

Commencing salary £180 per annum; the current Civil Service bonus, at present about £85, will be paid in addition.

In considering the limits of age some allowance will be made for war service.

No candidate will be accepted for an appointment who fails to pass a strict medical examination as to his physical fitness.

Forms of application can be obtained from Civil Engineer-in-Chief's Department, Admiralty, London S.W. 1. Applications must be made on the recognised form and should reach the CIVIL ENGINEER-IN-CHIEF, Admiralty, not later than 6th October. 3548

Building Inspector Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT, for a tour of 12 to 18 months' service in the first instance. Salary £450 a year for the first three years of service and thereafter £510, rising to £720 a year by annual increments of £30, and thence to £800 a year by annual increments of £40. Free quarters and passages. Outfit allowance of £60 on first appointment. Liberal leave in England on full salary. Candidates, not over 35 years of age, preferably single, should have had experience in the Building Inspector's Department of a Municipality and have a sound knowledge of surveying and building construction. Must be of active habits, as the whole tour will be occupied in travelling, and must be able to ride a motor bicycle.—Apply at once in writing, stating age, whether married or single, and giving brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/12,150. 3539

Technical College, Bradford.

DAY COURSES.

FULL-TIME (DAY) COURSES extending over three or four years, and leading to the Diploma of the College, are arranged in the following Departments:—
TEXTILE INDUSTRIES.
CHEMISTRY.
DYEING.
MECHANICAL ENGINEERING.
CIVIL ENGINEERING, ARCHITECTURE AND BUILDING.
ELECTRICAL ENGINEERING.
BIOLOGY.

These Courses are designed to meet the needs of Students wishing to present themselves for the Degree Examinations of the London University.

SPECIAL FACILITIES ARE AVAILABLE FOR ADVANCED STUDY AND RESEARCH.

Further particulars and prospectuses may be obtained on application to the PRINCIPAL, Technical College, Bradford. 3520

PUBLIC NOTICES

University of Birmingham.

CIVIL ENGINEERING DEPARTMENT.

Professor F. C. LEA, D.Sc., M. Inst. C.E., M.I. Mech. E., M.I. Mot.

COURSES in CIVIL ENGINEERING, leading to the Degree of B.Sc. and Higher Degrees, also COURSES in CIVIC DESIGN and TOWN-PLANNING. The NEW SESSION will COMMENCE on OCTOBER 1st, 1923.

Full particulars and syllabus can be obtained from Professor Lea or from the undersigned.

GEO. H. MORLEY, Secretary. 3520

The University of Sheffield.

SESSION 1923-24.

Vice-Chancellor:
SIR HENRY HADOW, C.B.E., D. Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the DEPARTMENT of ENGINEERING extend over three or four years and prepare students to become Mechanical, Electrical, Civil or Mining Engineers, or specialists in Fuel Technology or Glass Technology.

The Courses in the DEPARTMENT of METALLURGY cover a period of three or four years and prepare students for positions of responsibility either (1) in Iron and Steel Manufacture, or (2) in the Non-ferrous Metallurgical Industries.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular courses.

In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering and in Glass Technology, arrangements are made to enable students, who come to the University from works or collieries, to take six months' courses of study at the University and six months' practice at the works or colliery each year for a period of four years.

The LECTURE COURSES commence OCTOBER 3rd, 1923.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 25th, 1923.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to

W. M. GIBBONS, Registrar. 3290

The Yarrow Scholarships.

The Council of the Institution of Civil Engineers are prepared to consider APPLICATIONS for NOMINATIONS to the above SCHOLARSHIPS. These should be submitted before the 1st October, 1923, to the SECRETARY of the INSTITUTION, at Great George-street, Westminster, S.W. 1, from whom the detailed regulations may be had on application.

The Yarrow Scholars must be British subjects, who, desiring to become engineers, lack sufficient means to enable them to pursue their practical or scientific training.

The Scholarships are of a value varying from £50-£100 per annum. 3195

PUBLIC NOTICES

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic Institute, ST. JOHN-STREET, LONDON, E.C. 1.

ENGINEERING DAY COLLEGE.

Full-time Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and Aeronautical Engineering, and those in Electrical Engineering include specialisation in Radio-telegraphy.

A SPECIAL ENTRANCE EXAMINATION is held at the end of September before the commencement of each session. The Courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees £18 or £13 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £62 each for the complete Course will be offered for competition at the annual entrance examination in September.

OPTICAL ENGINEERING AND TECHNICAL OPTICS.

Full and part-time Courses in this important Department of Applied Science are given in specially equipped laboratories and lecture rooms. The annual Entrance Examination is held at the end of September.

EVENING TECHNICAL COURSES

in all branches of Mechanical and Electrical Engineering commence on Monday, September 24th, 1923.

The Laboratories, both Mechanical and Electrical, are well equipped with modern apparatus which, on the mechanical side, provides for specialisation in Automobile and Aeronautical Engineering, and, on the electrical side, for specialisation in Alternate and Continuous-current Work, in Radio-telegraphy and Telephony, and in Electrical Testing.

More complete particulars, together with conditions of entrance, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to

R. MULLINEUX WALMSLEY, D.Sc., Principal. 3453

University of Aberdeen.

CRUICKSHANK LECTURESHIP IN ASTRONOMY AND METEOROLOGY.

The University Court will proceed in autumn to the APPOINTMENT of a LECTURER in ASTRONOMY and METEOROLOGY. Salary £600 per annum.

Persons desirous of being considered for the appointment are requested to lodge their names with the Secretary to the University on or before 1st November, 1923, from whom further particulars may be obtained.

H. J. BUTCHART, Secretary.
The University, Aberdeen. 3182

University of Aberdeen.

JACKSON CHAIR OF ENGINEERING.

The University Court will proceed in autumn to the APPOINTMENT of the FIRST INCUMBENT of the JACKSON CHAIR of ENGINEERING, the patronage of which is vested in the University Court.

The salary is the free income from the endowment estimated at not less than £900 per annum, and the Professor will be allowed to undertake consulting work.

The Professor will enter upon his duties on a date to be arranged.

Persons desirous of being considered for the office are requested to lodge their names with the Secretary to the University on or before 1st November, 1923, from whom further particulars may be obtained.

H. J. BUTCHART, Secretary.
The University, Aberdeen. 3181

PUBLIC NOTICES

UNIVERSITY OF LONDON.

King's College.

FACULTY OF ENGINEERING.

COMPLETE COURSES of STUDY, extending over either three or four years, are arranged in CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.

The four years' Course provides, in addition to the academic training, opportunity for practical training in "Works."

HEADS OF DEPARTMENTS.

Professor G. COOK, D.Sc., M.I. Mech. E., A.M. Inst. C.E., Mechanical Engineering.
C. A. GENEVE, B.Sc., A.M.I. Mech. E., Senior Lecturer.
Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering.
C. H. LOBBAN, B.Sc., A.M. Inst. C.E., Senior Lecturer.
Professor E. WILSON, M. Inst. C.E., M.I.E.E. (Dean), Electrical Engineering.
R. E. SHAWCROSS, A.M. Inst. C.E., M.I.E.E., Lecturer.
Professor S. A. F. WHITE, M.A.; Professor G. B. JEFFERY, M.A., D.Sc., Mathematics.

Considerable extensions have been made in the Engineering Department. These include a large additional Drawing-office, Lecture Rooms, and Laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments; and Research Rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the three Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 3052

Huddersfield Technical College.

DEMONSTRATOR in MECHANICAL ENGINEERING REQUIRED AT ONCE. Ability to conduct Advanced Laboratory Classes in Mechanics and Heat Engines essential. Salary £250.—Further particulars on application to SECRETARY, Technical College, Huddersfield. 3455

City of Nottingham.

NORTH WILFORD POWER STATION.
CONTRACT NO. 5.

The Electricity Committee is prepared to receive TENDERS for the ERECTION of BUILDINGS in connection with the North Wilford Power Station.

Drawings may be seen and copies of the general conditions of contract, specification, bill of quantities, and form of Tender, &c., may be obtained on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of Two Pounds, which will not be returned.

Sealed Tenders are to be delivered in the official envelope provided to the undersigned not later than 9 a.m. on Friday, the 5th October, 1923.

The lowest or any Tender will not necessarily be accepted, and the Committee reserve to themselves the right of dividing the work in any way they may think fit, and Tenders will only be accepted from firms who conform to the conditions of the contract as regards paying the local standard rate of wages, &c., and to the working rules of the Nottingham district.

By Order,
W. J. BOARD, Town Clerk.
Guildhall, Nottingham,
8th September, 1923. 3517

County Borough of Walsall.

ELECTRICITY SUPPLY DEPT.
CONTRACT NO. 27.

The Electric Supply Committee of the Walsall Corporation invite TENDERS for the SUPPLYING, DELIVERY, and ERECTION of:—

TWO BOILER UNITS, complete with SUPERHEATERS, SUPERIMPOSED ECONOMISERS, and STEEL CHIMNEYS, FEED PUMP, PIPE WORK, and AUXILIARIES.

Copies of the specification, conditions of contract, &c., may be obtained on or after the 19th inst. upon application to the Consulting Engineer, Mr. E. M. Lacey, M. Inst. C.E., 12, Victoria-street, Westminster, S.W. 1, on payment of £5 5s., which will be returned on receipt of a bona fide Tender.

Tenders, sealed and endorsed on the outside "Electric Supply Committee. Tender for Boiler-house Plant," to be addressed to the Town Clerk, Walsall and delivered to him not later than 10 a.m., Wednesday, the 10th October next.

The contractor whose Tender is accepted will be required to enter into a formal contract with the Corporation for the due performance of the work specified, and such contract would include the Corporation's usual clause ensuring that the contractor pays to all workmen employed the standard rate of wages current in the district in which the work is performed.

The Committee do not bind themselves to accept the lowest or any Tender.

HERBERT LEE, Town Clerk.
Council House, Walsall,
12th September, 1923. 3548

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
PATENTS, Page 3.
MACHINERY, &c., WANTED, Page 3.
FOR SALE, Pages 3, 4 and 102.
AUCTIONS, Pages 3 and 102.
PREMISES TO LET OR WANTED Page 3.
WORK WANTED, Page 4.
AGENCIES, Page 3.
MISCELLANEOUS, Page 3.

For Advertisement Rates see Page 283, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 101.

PUBLIC NOTICES

County of London.

The London County Council invites TENDERS for the DEMOLITION and REMOVAL of STEEL and BRICK-LINED CHIMNEY STACK, which may be inspected at the London United Electric Tramways Power Station, 74, High-road, Chiswick, between the hours of 10 a.m. and 4 p.m. on any weekday, except Saturdays, from 17th September to 1st October, 1923, both dates inclusive, by appointment with a representative of the London County Council.

Particulars and form of Tender may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C. 2.

No Tender will be considered if received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after Twelve Noon on Tuesday, 2nd October, 1923.

The Council does not bind itself to accept the highest or any Tender.

JAMES BIRD,
3527 Clerk of the London County Council.

County of London.

The London County Council invites TENDERS for the SUPPLY, DELIVERY, and ERECTION of ONE 15,000 K.W. STEAM TURBO-ALTERNATOR, CONDENSING PLANT, &c.

The specification, form of Tender, and general conditions may be obtained from the General Manager, Tramways Department, Victoria Embankment, W.C. 2, on payment of a deposit of £2, which will be refunded if a bona fide Tender is submitted and not subsequently withdrawn. Particulars of the work may be obtained on application to the General Manager of Tramways before payment of the deposit.

Tenders must be delivered to the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Monday, 15th October, 1923. No Tender received after that time will be considered.

The Council does not bind itself to accept the lowest or any Tender, and reserves the right to accept Tenders for either section of the work.

JAMES BIRD,
3528 Clerk of the London County Council.

Ely Rural District Council.

WATER SUPPLY.

The Ely (Cambs.) Rural District Council invite TENDERS for the undermentioned WORKS:—

CONTRACT No. 1.—SUPPLYING and INSTALLING THREE-THROW RAM PUMPS, capacity 3000 gallons each per hour, and SEMI-DIESEL CRUDE OIL ENGINES.

CONTRACT No. 1A.—SINKING TWO 20in. BOREHOLES, 60ft. deep.

CONTRACT No. 2.—LAYING and JOINTING about 35 MILES of 7in., 3in., and 2½in. MAINS.

CONTRACT No. 3.—CONSTRUCTION OF TWO REINFORCED CONCRETE WATER TOWERS, capacity 100,000 gallons each.

CONTRACT No. 4.—SUPPLYING and DELIVERING approximately 2000 TONS of CAST IRON PIPES and SPECIALS.

CONTRACT No. 5.—SUPPLYING and DELIVERING CAST IRON VALVES and FITTINGS.

Plans may be seen and specifications, bills of quantities, and forms of Tender obtained at the Rural District Council Offices, 11, Lynn-road, Ely, Cambs., on application to the undersigned.

In respect of Contracts Nos. 2 and 3 a deposit of £5 will be required, which will be returned on receipt of bona fide Tender and the return of all documents supplied.

Sealed and endorsed Tenders, on the forms supplied, are to be delivered to the undersigned not later than 10 a.m. on the 10th October, 1923.

For the convenience of contractors the Engineer (W. L. E. Wilson, B.A., M. Inst. C.E., 12, Cavendish-avenue, Cambridge) will attend at the Rural District Council Offices, Ely, by appointment.

The Council do not bind themselves to accept the lowest or any Tender.

F. W. GREEN,
Clerk to the Council.

Council Offices,
11, Lynn-road, Ely, Cambs.,
12th September, 1923. 2123

The Great Indian Peninsula

RAILWAY COMPANY, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for:—
40-TON BOGIE SELF-DISCHARGING BALLAST WAGONS. Fee £1.

Tenders due by 11 a.m. on Tuesday, the 9th October, 1923.

Tender forms obtainable at above address. 3551

The Great Indian Peninsula

RAILWAY COMPANY 48, Copthall-avenue, London, E.C. 2, invite TENDERS for:—
GIBS AND COTTERS.
STEEL RAILS AND FISH-PLATES.
CAST IRON CHAIRS.
POINTS AND CROSSINGS, &c.
STEEL FISH-BOLTS, CHAIR-BOLTS, &c.
SHEFFIELD TOOLS.
AXLE-BOXES.
SPARE PARTS OF CARRIAGES AND WAGONS.

Tenders due by 11 a.m. on Tuesday, the 25th September, 1923.

Tender forms obtainable at above address. 3552

SITUATIONS OPEN

WANTED, ENGINEERS' QUANTITY and PRIME COST CLERK for London district, accustomed to taking out quantities from drawings, &c.—Address, stating full particulars past experience, together with copies of references, age, and salary required, 3554, The Engineer Office. 3554 A

WANTED for India, ASSISTANT ENGINEER; practical and technical training, age about 23, three years' agreement.—Write, stating experience, to Z.T. 634, care Deacon's, Leadenhall-street, London. 3542 A

WANTED, STEEL CONSTRUCTION DESIGNER for Engineers in Eastern Counties.—Address stating age, particulars and salary required, 3430, The Engineer Office. 3430 A

ASSISTANT CIVIL ENGINEER, Single, Not Over 30, professional training and experience of Track and Construction abroad under contractors. Knowledge of French.—Write, Box 1948, c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 3557 A

ASSISTANT TRACK ENGINEER and FOREMAN PLATELAYER WANTED for large Tramway System, South Africa; must be thoroughly experienced, able to take full charge on all systems of track-work and methods of laying same, also roadways of granite, wood blocks, tar-macadam, Pisecora, and rail welding by electricity and Thermit, &c.—Address, stating age, full particulars, experience, and salary required, 3541, The Engineer Office. 3541 A

D.Sc. and all ENGINEERING DEGREES from University by correspondence. Experienced students only.—Write for particulars, enclosing postage.—Address, P8000, The Engineer Office. P8000 A

LARGE COTTON MANUFACTURERS REQUIRE fully qualified MAN as PRINCIPAL ASSISTANT to the Chief Engineer having charge of all power and construction work at various mills. Applicants must have thorough experience in Steam and Electrical Power and Lighting as applied to textile factories and be capable of preparing plans and specifications on own account. State age, experience, and salary required.—Address, 3530, The Engineer Office. 3530 A

REQUIRED, YOUNG ENGINEER, Age About 23 or 24, at Depot abroad; good technical knowledge of engineering, combined with workshop experience, for period three years.—Write, stating age, experience, and salary required, enclosing references, to Z. R. 611, c/o Deacon's, Leadenhall-street, London. 2522 A

LONDON COUNTY COUNCIL.

ENGINEERING

(AERONAUTICAL, CIVIL, ELECTRICAL, GAS, MARINE, MECHANICAL, MOTOR CAR, AND STRUCTURAL).

DAY AND EVENING CLASSES.

Battersea Polytechnic, Battersea Park Road, S.W. 11.	Full-time Day Courses in Mechanical Engineering, Civil and Constructional Engineering, and Electrical Engineering. Evening Classes in Mechanical, Civil, and Electrical Engineering. Trade Classes (including Classes for Motor Drivers).
Borough Polytechnic, Borough Road, S.E. 1.	Day Technical School for Boys intending to enter the Engineering Trades. Evening Classes in Mechanical Engineering (including Motor Car Engineering), Electrical Engineering. Trade Classes.
Finsbury Technical College, Leonard Street, City Road, E.C.	Full-time Day School only in Mechanical, Civil, and Electrical Engineering.
Goldsmiths' College, New Cross, S.E. 14.	Evening Classes in Electrical, Mechanical, and Constructional Engineering. Trade Classes.
Hackney Institute, Dalston Lane, E. 8.	Day Technical School of Engineering. Evening Classes in Electrical, Mechanical, Motor Car, and Structural Engineering.
Northampton Polytechnic, St. John Street, Clerkenwell, E.C. 1.	Civil, Mechanical (including Aeronautical), and Electrical Engineering. Full-time Day School and Evening Classes. Day and Evening Courses in Optical Engineering, and Part-time Courses for Apprentices in the Electrical Trades.
Paddington Technical Institute, Saltram Crescent, W. 9.	Day Technical School of Engineering. Evening Classes in Electrical and Mechanical Engineering.
Regent Street Polytechnic, Regent Street, W. 1.	Civil, Electrical, Motor Car, and Mechanical Engineering. Day School and Evening Classes. Evening Classes in Aeronautical and Gas Engineering.
School of Engineering and Navigation, High Street, Poplar, E. 14	Day Technical School of Engineering. Evening Classes in Electrical, Marine, and Mechanical Engineering.
Wandsworth Technical Institute, High Street, Wandsworth, S.W. 18.	Evening Classes in Mechanical Engineering.
Westminster Technical Institute, Vincent Square, S.W. 1.	Evening Classes in Civil and Gas Engineering.
Woolwich Polytechnic, William Street, Woolwich, S.E. 18.	Day School for Boys intending to enter the Engineering Trades. Part-time Day Courses for Engineer and Trade Apprentices. Evening Classes in Mechanical, Structural, and Electrical Engineering. Surveying. Special Lectures in Motor Engineering. Trade Classes.

Full particulars as to fees, etc., may be obtained on application at the various Institutions.
Evening Classes open 17th September, 1923.

JAMES BIRD,
Clerk of the London County Council.
3519

SITUATIONS OPEN (continued)

WORKS MANAGER WANTED for Small Dublin Factory employing up to 100 hands on repair of Telephones and Telegraph Apparatus and Manufacture of small lines of Engineering Stores.—Address, stating salary required and giving age, nationality, experience, and qualifications, 3537, The Engineer Office. 3537 A

WANTED, CHIEF DRAUGHTSMAN by Firm of Electrical Engineers. Must be capable of taking entire responsibility for mechanical design and ventilation of all types of A.C. and C.C. Machines up to 5000 H.P. Must be a good disciplinarian, accustomed to control of staff.—Address, stating age, experience, and salary required, 3439, The Engineer Office. 3439 A

WANTED, CHIEF DRAUGHTSMAN for Midlands. Must have sound knowledge of design, be expert calculator, with first-class training, including shop experience. State age, qualifications, &c.—Address, 3543, The Engineer Office. 3543 A

WANTED for a General Engineering Works Within 20 miles of Oxford, a first-class CHIEF DRAUGHTSMAN to Take Charge of Drawing-office containing six to eight employees and prepare estimates. Applicants must have had at least 18 years' engineering and drawing-office experience. Full particulars of class of work, names of firms employed by (accompanied by copies of references), and salary required, are to be stated.—Write, "A. C.," c/o Charles Barker and Sons, Ltd., 31, Budge-row, E.C. 4. 3518 A

CONSTRUCTIONAL ENGINEER DRAUGHTSMAN, under 30; must be well up in Detailing Steel-framed Buildings, Roof Principals, &c.; good at calculations; £5 per week.—Address, E. D. 865, care Deacon's, Leadenhall-street, E.C. 3533 A

DRAUGHTSMAN REQUIRED, Experienced in Air-screw Design. Ex-Service man preferred.—Apply, with full particulars of experience and salary required, to SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 3529 A

DRAUGHTSMAN REQUIRED for Aero-engine Work. Must have good technical and shops training and experience on similar work. Ex-Service man preferred.—Apply, giving full particulars and stating salary required, to SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 3536 A

DRAUGHTSMAN WANTED by Firm in N.W. London, with absolutely first-class mechanical knowledge. Some electrical experience would be of assistance. Good salary for the right man.—Address, stating age, salary, and experience, 3522, The Engineer Office. 3522 A

DRAUGHTSMAN WANTED IMMEDIATELY by General Engineering Firm on Tyneside. Must be quick, accurate, and thoroughly experienced in the designing of all kinds of Cranes and Pumping Machinery. State experience and salary.—Address, 3531, The Engineer Office. 3531 A

DRAUGHTSMAN WANTED, London, for Light Structural Sheet Metal Work, Ventilating Plants. State full particulars, training, experience, age, and salary required.—Address, 3544, The Engineer Office. 3544 A

DRAUGHTSMEN WANTED; Required for Steel Caissons, Dock Gates and Heavy Opening Bridges, General Dock Construction Work, including Permanent Way and Buildings. Only men who have actually been recently engaged upon the design and detail drawings of such work need apply.—Applications, stating age, salary required, and full particulars of training and experience, and when at liberty, to STAFF MANAGER, Port of London Authority, London, E.C. 3. 3464 A

SITUATIONS OPEN (continued)

REQUIRED, DRAUGHTSMAN; First-class Experience essential; used to design of Front and Rear Axles for Touring Cars and Commercial Vehicles. State age, experience, and salary required to KIRKSTALL FORGE, Ltd., Leeds. 3550 A

THE CHATWOOD SAFE CO., Ltd., Bolton, REQUIRE the SERVICES of a first-class LEADING DRAUGHTSMAN possessing initiative and proved designing ability.—Applications should be addressed to "CHIEF DESIGNER," stating age, experience, and salary required. 3524 A

YOUNGER DRAUGHTSMAN, with Experience in Designing Tubular Heat Exchange Apparatus, REQUIRED. State age, salary required, and when able to start, also give references and curriculum vitæ.—Address, 3515, The Engineer Office. 3515 A

WANTED, FOREMAN, Capable of Taking Charge of Erection Shop of large Electrical Manufacturers. Must have had experience of large and medium size A.C. and C.C. machines; accustomed to control men; previous experience essential.—Address, stating age, qualifications, and salary required, 3438, The Engineer Office. 3438 A

SHORTHAND-TYPIST REQUIRED, Specially experienced in dealing with Engineers' Small Tool and Machine Tool Business, by important engineering concern in Westminster. Must be capable of rapid and accurate work.

Also SHORTHAND-TYPIST REQUIRED, thoroughly experienced in Publicity Work, including Technical Publicity and Catalogue Lay-outs.—Apply by letter, Box No. 880, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 3459 A

SITUATIONS WANTED

ADVERTISER, A.M.I. Mech. E., Shortly Disengaged, 20 years' experience in sawmill management at home and in the East, DESIRES suitable responsible APPOINTMENT either in similar capacity or in connection with the inspection and conversion of teak and valuable hardwoods. Thoroughly conversant with the design, erection, and running of modern plants for maximum economic output. Good organiser, office experience.—Address, P8013, The Engineer Office. P8013 B

CIVIL ENGINEER DESIRES POSITION in London or district with commercial firm for experience. Wide experience home and abroad, railway and other construction works. Accept moderate salary.—Address, P8025, The Engineer Office. P8025 B

ELECTRICAL and MECHANICAL ENGINEER, with 27 years of practical and commercial experience, is now OPEN for APPOINTMENT, England or abroad; highest references given.—Address, P7939, The Engineer Office. P7939 B

ENGINEER (34) DESIRES POSITION; 14 Years' sound experience in all branches of engineering, construction and maintenance in large works, used to control.—Address, P8029, The Engineer Office. P8029 B

FOUNDRY MANAGER.—ADVERTISER, Well Educated, capable organiser, all-round engineering knowledge, especially machine moulding, and of good character, DESIRES MANAGEMENT of Medium-sized FOUNDRY or small ENGINEERING WORKS.—Address, P8028, The Engineer Office. P8028 B

GENTLEMAN DESIRES APPOINTMENT as South Wales REPRESENTATIVE to Firm Mining Plant Manufacturers. Energetic, good address, 10 years' technical and commercial experience, thorough knowledge of district.—Address, P8031, The Engineer Office. P8031 B

SITUATIONS WANTED (continued)

HEAVY OIL ENGINES.—ADVERTISER, Who Has had exceptional experience in the design of semi-Diesel and cold-starting engines, is OPEN for ENGAGEMENT. Highest references; would guarantee results.—Address, P8021, The Engineer Office. P8021 B

INDUSTRIAL ENGINEER ADVISES on Factory Lay-outs and Organisation, Installation of Modern Methods for Control of Stocks, Production, and Costs in Large and Small Plants.—Address, P8015, The Engineer Office. P8015 B

MECHANICAL ENGINEER, Having Held Position as works manager and works foreman for the past sixteen years, REQUIRES similar POST, home or abroad. Twenty-four years' general engineering experience, including modern production of automobiles and automatic machinery; age 40; excellent credentials.—Address, P7909, The Engineer Office. P7909 B

MECHANICAL ENGINEER (35), M.I. Loco. E., with energy and ability, trained G.W. Ry., 10 years' railway loco. experience, Indian and colonial railways, and now holding responsible post India, DESIRES CHANGE, England or abroad, view greater opportunity.—Address, P8009, The Engineer Office. P8009 B

RUSSIA.—BRITISH CIVIL ENGINEER, B.Sc. London, retired regular Army officer, at present engaged in structural steel in U.S.A., WISHES to get in TOUCH with FIRM doing CONSTRUCTION WORK in Russia. Sound knowledge of Russian language and people.—Address, 3545, The Engineer Office. 3545 B

RUSSIA.—ENGLISHMAN (Age 42) with 20 Years' foreign trading experience, principally in Russia (machinery), DESIRES POSITION. Perfect fluent Russian language. Good references. Willing travel abroad.—Address, 3526, The Engineer Office. 3526 B

STRUCTURAL ENGINEER, A.M.I.C.E., (27), SEEKS POSITION in London district as Assist. Engr.; 5 yrs. shop, 3 yrs. D.O., 2 yrs. assist. civil engr.; expd. on design, estimating, specifications and quantities of light structural buildings and wireless towers.—Address, P8017, The Engineer Office. P8017 B

WORKS MANAGER SEEKS Similar POSITION. Age 40, good organiser and controller, well up in production of small parts, thorough practical experience.—Address, P8023, The Engineer Office. P8023 B

DRAUGHTSMAN (32), Shop Experience for 2 Years on aeroplane construction and 5 years D.O., die casting, and general engineering, REQUIRES similar POSITION.—Address, P8039, The Engineer Office. P8039 B

DRAUGHTSMAN (32), Experienced in Details and design of steel structural work, DESIRES CHANGE; competent and reliable, moderate salary.—Address, P8007, The Engineer Office. P8007 B

ENGINEERING STUDENT (22) REQUIRES OPENING as JUNIOR DRAUGHTSMAN, preferably structural work. Good technical and practical training; student I.C.E., about to take final.—Address, P8006, The Engineer Office. P8006 B

LADY TRACER, Highly Qualified, Ex. Rly., 3 years' experience, SEEKS SIT. in London.—Apply, I. EDWARDS, 11, Cuthbert-road, Bath. P8011 B

YOUTH (17) REQUIRES SITUATION in Engineers' Drawing-office; 2½ yrs. experience in London engineers' D.O., passed all exams. at Stanley Inst. last year.—S. H., 62, Woodlands Park-road, Harringay, N. 15. P8014 B

FOUNDRY FOREMAN DESIRES CHANGE; thoroughly exp. light and heavy floor, marine moulding, all irons and non-ferrous metals; good organiser with initiative; up-to-date methods; good refs.—Address, P8020, The Engineer Office. P8020 B

PATTERN SHOP FOREMAN DESIRES CHANGE; 8 years' charge in high-class engineers, thoroughly experienced in marine, electrical, and general engineering; accuracy, economy, and quick output guaranteed; highest references; age 40.—Address, P8026, The Engineer Office. P8026 B

MACHINE SHOP FOREMAN DESIRES RE-ENGAGEMENT; age 32; last situation 3½ years, conversant with modern methods repetition production; strict disciplinarian and timekeeper, and possessing initiative; home or abroad.—Address, P8005, The Engineer Office. P8005 B

BOILERMAKER (Plater and Angle Iron Smith), 5 years' apprenticeship P. and O. Co., 5 years' sea-going experience, 6 years' technical training, Hindustani, used tropics, disciplinarian; abroad if necessary. Highest references.—Address, P8004, The Engineer Office. P8004 B

MOULDER, Thoroughly Practical, SEEKS SITUATION; first-class experience in all kinds of engine work, also brickie and machine moulding; steady timekeeper and conscientious worker; anxious for reliable position.—P. DRAYTON, Chidcock, Bridport. P8018 B

COMMERCIAL RECONSTRUCTIONS, LTD.,
1, POST OFFICE CHAMBERS, DERBY.

The Company takes hold of substantial non-paying concerns and re-organises and revitalises them, both technically and financially, to the dividend-paying stage.

The fullest investigations are invited and required.

PARTNERSHIPS

PARTNERSHIPS
ENGINEERING
AND
BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.

Established seventy years.

ENERGETIC MAN, Preferably Engineer with Commercial experience, is INVITED to ASSIST in EXTENDING the very profitable BUSINESS of old-established registered company ripe for great development, if mutually satisfied, directorship could be arranged. £2000 incoming.—Address, 3553, The Engineer Office. 3553 C

TWO ENGINEERS.—MECHANICAL and CIVIL ENGINEERS REQUIRING ACTIVE DIRECTORSHIPS, with full-time occupation and investment of capital from £2000 to £5000, in Engineering, Constructional or allied businesses, open to solicitors' and accountants' investigation, should write Box B4694, Francis and Co., 131, Fleet-street, E.C. 4. 3495 C

For continuation of Small Advertisements see page 3

A Seven-Day Journal

New Magnetic Testing Station.

THE negotiations which, as we reported in the Journal for August 24th, the Admiralty was conducting for the purchase of about eight acres of land at Holmbury Hill, Surrey, in order to provide a new site for the magnetic testing station free from the electrical interferences which disturb the work of the existing station at Greenwich have, it seems, fallen through. Considerable public opposition was expressed against the "desecration" of Holmbury Hill, a well-known beauty spot, and the Admiralty apparently has bowed its head to the storm. Various alternative sites have been suggested, but we understand that a decision has now been reached to erect the station on private land a mile and a-half to the east of Holmbury. The new site has received the approval of the Astronomer Royal and the Admiralty's scientific advisers.

An Air Mail Experiment.

FURTHER information regarding the air mail experiment referred to in last week's Journal are now available. The experiments were due to begin on Wednesday of this week, and are being conducted on behalf of the Air Ministry by the de Havilland Company. At six-thirty in the morning, according to the programme, an aeroplane is to leave Plymouth with a dummy bag of mails supposed to have been landed from liners which have reached the port since three o'clock the previous afternoon. The machine will proceed to Birmingham and Manchester, stopping ten minutes at each place, and will then fly, without landing, *vid* Carlisle and Stranraer to Belfast. It is intended that Birmingham shall be reached at 8.30 a.m., Manchester at 9.30 a.m., and Belfast at 1 p.m. Should no mails arrive at Plymouth during the night the start may be delayed until 10 a.m., and if there should still be no arrival by that time a machine will be dispatched at 1.40 p.m., but will not proceed beyond Manchester. On the return journey a machine is to leave Belfast at 2 p.m. and fly to Manchester, where it will stop for the night, and then proceed *vid* Birmingham to Plymouth the next morning. The aerodrome at Belfast being some distance from the centre of the city, it is proposed to experiment with the dropping of the mails by parachute on a site near the General Post Office. If this portion of the experiment be successful it is intended to drop dummy bags in a similar way at Carlisle or Stranraer for connection with the Scottish railways. The experiments will involve the use of four D.H. 9c machines, and possibly of one of the new D.H. 50 type, and as these machines have passenger accommodation in addition to mail space it is intended when occasion serves to carry passengers on them as well as the mails. It is estimated that some twenty-four hours will be saved in the distribution of the American mails at Belfast and proportionately less at the intermediate cities. The experiments are to be continued over a period of a month.

The Loss of the Trevessa.

AN inquiry by the Marine Court of Mauritius into the loss on June 4th of the ss. Trevessa in the Indian Ocean—a disaster illuminated by the Homeric voyages of the two boat loads of survivors—has resulted in a finding that the vessel was lost through a serious leak in No. 1 hold, a mishap to which no cause except straining in heavy weather could be assigned. The Court found that the pumps were in good condition, and that the master and crew did everything in their power to save the vessel, abandoning her only just in time to prevent the loss of life. The British Board of Trade, having considered the report of the Mauritius Court, has instructed its solicitor to take the necessary steps to have the case re-heard in this country under the provisions of the Merchant Shipping Act, 1894. It is surmised that this re-hearing has been decided upon with a view to determining, if possible, the precise cause of the leak.

Einstein and Monday's Eclipse.

MONDAY'S total eclipse of the sun visible over a region of some 2000 square miles in California and Mexico, presented another opportunity for the experimental confirmation of the theory of relativity. It appears, however, that no particular efforts were made so to use it on the ground that the supporters of Einstein do not consider that further confirmation obtainable from the observation of the bending of stellar rays by the gravitational field of the sun is necessary. It may be recalled that the British expedition to observe the solar eclipse of 1919 brought home with it results which were accepted by many eminent authorities as quite definitely supporting Einstein's views, although by others they were challenged in a very critical and damaging way. Confirmation was sought at the time of the eclipse last year, but the expedition sent by Greenwich Observatory to Christmas Island was completely baffled by unfavourable weather just at the instant when it was desired to take photographs. The Canadian expedition to the north coast of Australia on the same occasion obtained results of little or no value one way or the other. The American expedition, however, secured records which it was held clearly confirmed the 1919 deductions. As a consequence of that confirmation it was decided not to send a party from Greenwich to observe Monday's eclipse. Expeditions from the Mount Wilson and Yerkes observatories and other American institutions were on the spot, but their activities were chiefly concerned with photographing the sun's chromosphere and scarcely, if at all, with the Einstein effect. Thus so far as this particular field for the experimental confirmation of the theory of relativity is concerned, we are apparently to be asked to remain content with one major demonstration and one confirmation. Science surely demands much, very much, more.

Re-opening the Maltby Main Colliery.

WHEN the disaster at the Maltby Main Colliery occurred on July 28th, whereby twenty-seven men lost their lives, a portion only—that on the east side—of the workings was seriously damaged. Very soon after the mishap it was decided to seal off the affected area, for it was recognised that there could be no hope of re-opening it for working in the near future. Work to this end has since been progressing actively. The sealing operation has been effected by means of explosion-proof doors, behind each of which 20 yards of earth have been piled 8ft. high. To a certain extent the sealing affected the ventilation of the west side of the pit, with the result that a large volume of gas accumulated in that section. Matters in this respect were, however, put right by the driving of a new roadway connecting the two airways, with the result that conditions have now been created which make the resumption of work possible. The first shift descended the pit last Sunday night, but as a certain amount of cleaning up of the roads was required, actual coal-getting could not be undertaken at once. It was hoped, however, to re-start such work by the end of this week or, at any rate, not later than next Monday.

The Harwich Train Ferry Bridge.

ON the 1st of the month, after a fortnight's waiting for favourable weather, the bridge used at Southampton during the war in connection with the cross-Channel train ferries was towed to sea on two barges, its destination being Harwich, where it was once more to be put into service by Great Eastern Train Ferries, Limited, on the Harwich-Zeebrugge route. On the 4th inst, however, when about eight miles off Harwich, one of the barges is stated to have collapsed and sunk. The other barge remained afloat, but one end of the bridge was firmly held by the sunken barge. Immediate and sufficient help was not forthcoming to save the bridge, and on the succeeding day it slipped over into the water, taking the second barge down with it. Divers have since investigated the situation, and it is reported that salvage operations are practicable. The bridge weighed 380 tons and, in addition, the barges carried 250 tons of accessories. The Harwich-Zeebrugge service was to have been operated in conjunction with the London and North-Eastern Railway and the Belgian State Railways. The Ferry Company acquired from the Government three ferry boats, the bridges and the accessories for a sum of approximately £200,000. It is to be expected that while the mishap may delay the initiation of the service, it will not lead to the scheme being abandoned.

Future Supply of Skilled Artisans.

WE are glad to notice that at a distribution of prizes to apprentices Sir Archibald Ross, managing director of Hawthorn, Leslie and Co., Limited, expressed himself as seriously concerned about the supply of skilled workers in the future—the subject of one of our leading articles in last week's issue. From his remarks it can be inferred that one firm at least recognises the menace to the engineering and shipbuilding trades contained in the smallness of the number of new apprentices at present being started and the drain produced by emigration among the fully trained skilled workers. As regards emigration, he stated that his fellow directors and himself were fully alive to the situation, and were taking every possible step to guard against its evil consequences in the future.

Lost Vessels.

LLOYD'S "Returns of Vessels Totally Lost, Condemned, &c.," for the first quarter of this year, issued this week, shows that wrecking both for steam and motor vessels and for sailing ships continues to be by far the most serious cause of marine loss. In the matter of steam and motor vessels this country is at the head of the list in the number of vessels lost, namely, with twenty-four of a total tonnage of over 21,000 tons, of which number sixteen were wrecked, four lost by collision, three by foundering, and one by being abandoned at sea. Nevertheless, expressed as a percentage of the tonnage owned, the figures place this country very nearly at the foot of the list with 0.11 per cent. The most unfortunate country was apparently Italy, which lost thirteen vessels, or 1.46 per cent. of the total tonnage owned. Germany came second from the wrong end, having lost fourteen vessels, representing 0.87 per cent. of her total steam and motor tonnage. Burning caused the loss of eight vessels, of which four belonged to the United States, the remainder being distributed one each among four other countries. In the sailing ship list the worst sufferer was the United States, which lost 5.28 per cent. of the total tonnage owned of this class, Germany being second with 2.08 per cent. Great Britain was at the foot of the list with two vessels, representing 0.37 per cent. of our total sailing tonnage. Altogether the total world loss during the quarter was 161,019 tons.

The Diggle Railway Accident.

THE report by Colonel Pringle on the collision on July 5th at Diggle, on the London, Midland and Scottish Railway, was issued last Friday. It will be remembered that a goods train on the up south line was allowed to draw forward past the home signal, 256 yards from the signal-box, up to a red flag exhibited at the box. Afterwards, as an express was approaching on the up north line, the signalman had to withdraw the red flag, but he took no steps to tell the driver of the goods train not to move. The signals were lowered for the express to cross on to the up south line by a junction, the fouling point of which was 72 yards in advance of the point at which the goods train had come to rest. When the shunter was ready he informed the driver of the latter train to that effect, and gave the usual "draw-forward" hand signal. The driver, however, should have accepted this hand signal only as an intimation that the shunter was ready and he should not, in view of having been stopped by a red flag, have moved until he had received permission from the signalman. He, however, went ahead and as a result fouled the path of the express. In the consequent collision he himself was killed, as were two passengers and the fireman of the leading engine of the express. In placing the main responsibility for the accident on the driver of the goods train and to a lesser extent on the signalman, the shunter and the goods guard, Colonel Pringle recommended an inner home signal at the point at which the goods train was standing and better drafting of the working rules so as to cover the conditions that prevailed, as there is no rule as to what must be done if a red flag has to be taken in nor as to a green flag succeeding a red.

Safety in Mines.

THAT safety in coal mines is now considerably greater than it was a few decades ago, is clearly indicated in the first report of the Safety in Mines Research Board issued this week. The report analyses the number of accidents in the ten years ended 1920, and compares the figures with those for the ten years beginning 1873. Per million workers employed, accidents arising from falls of ground have decreased from a yearly average of 1124 to 743, those arising from explosions of fire-damp or coal dust from 661 to 111, those from mechanical causes connected with the shafts from 323 to 75, and those from similar causes connected with the haulage system from 317 to 304. Other accidents below ground fell from a yearly average of 155 to 135. Altogether, it appears that safety in coal mines increased in the ratio of 7 to 3 between 1873 and 1920. Evidence is supplied to show that had the survey been extended to 1922, the improvement would have been still greater. Commenting on the figures, the Committee expresses the belief that the enormous decrease of accidents resulting from explosions of fire-damp or coal dust is to be attributed to the research work undertaken at Altofts and Eskmeals, to the regulations relating to the use of safety lamps in gassy mines, to the improved arrangements made for searching the workers and to the regulations relating to the use of explosives, electricity and machinery underground. The reduction in shaft accidents is equally noteworthy, and is ascribed to the adoption of improved methods. It will be noted that haulage accidents have barely been decreased, and that under the heading of falls of ground the reduction is far less than in the other categories. In the latter connection, the Committee states that the personal factor enters very largely into the matter. In general, it is believed that one-third of the fatal accidents in mines in a given year (1921) was preventable by the action of the management or the workers. In these circumstances the Committee expresses the opinion that any large reduction in coal mine accidents in the future can only be achieved by "safety first" and other methods affecting the personal factor, although scientific research and improvements in mining practice should also contribute to that end.

The L.C.C. Automatic Telephone Exchange.

ON Saturday the private branch telephone system at the London County Council's new Hall was changed over from manual to automatic working. Provision is made in the new plant for 700 extension telephones, 650 of which will be operated automatically and 50 manually, and allowance has been made for an increase up to 900 extensions. Calls to and from the outside public will continue to be made through a manual switchboard.

Science and Industry in America.

By WALTER ROSENHAIN, D.Sc., F.R.S.

No. I.

A CRITICAL appreciation of the relations of science to industry throughout so large a country as the United States of America would be a fitting task either for one who has had a lifelong direct association with the work itself in America or who has, at least, been in a position to devote many months to the close study of the subject. The present writer cannot claim such detailed, intimate knowledge of this large subject, but a recent visit to America has given him an opportunity to obtain something like a bird's-eye view of the situation. A rapid tour of the North-Eastern States, as far west as Chicago, devoted mainly to the inspection of industrial establishments and research laboratories, for which at all times the greatest facilities and courtesies were offered, has allowed him to gain an insight into certain aspects of the whole question, and, with the reservation that the data are by no means complete, has led him to certain conclusions. These, in view of his own intimate association with the application of science to industry in this country, naturally take the form of comparison. Such a comparison is not, and should not be, regarded as invidious; the conditions governing both science and industry in the two countries differ so widely that it is not likely that identical methods in either would serve equally in both. Yet each has, undoubtedly, much to learn from the other, not only in regard to methods and facts, but in regard to mutual understanding and appreciation. Nowhere is there more room and need for international co-operation than between the men of science and technology of the two English-speaking nations.

Any study of the relations of industry to science must resolve itself into an examination, in the first place, of the concrete manifestations, such as laboratories and industrial operations based on scientific discovery or guided by the definite application of scientific principles, and, in the second place, into an appreciation of the underlying spirit by which the relations of science and industry are governed—the attitude of mind of the industrial executive towards science and of the scientific investigator towards industry. This latter part of the question presents much the greater difficulty, since it is necessarily a question of impressions and opinions rather than of definite fact. None the less, this aspect of the subject must be considered before the concrete installations and applications can be rightly appreciated.

In America, as in this and every country, the main object of business, whether manufacturing or otherwise, is necessarily financial success, and the first and in many cases the only consideration which governs the attitude of "business" towards science is determined by the simple consideration whether the application of science can directly and immediately increase the profits of the business. It is quite clear, from the very great extent to which scientific methods and appliances have been adopted in American industry, that in one rather limited sense the answer to the above questions appears to be affirmative. It is, in this respect, a direct and logical development of the very far-reaching application of automatic machinery. Partly as a result of labour conditions, partly as a result of a definitely progressive spirit which values an advance for its own sake, automatic machinery is universally preferred to skilled human effort. A machine that "saves so many men" is immediately adopted, and if a better machine appears there is little reluctance in displacing the older by the newer. In the ordinary sense, new automatic machines can scarcely be regarded as products of scientific research or discovery, although in many cases the new appliance is rendered possible only by the aid of some new material or device which industry definitely owes to science; that consideration, however, scarcely bears on the present point of view. It is in other more direct ways that applications of science become part of the "automatic" equipment in American works practice. One of the most striking examples of this kind of application is to be found in the widespread use of thermo-electric pyrometers, recorders, and automatic temperature-control potentiometers. Here is a case where the American manufacturer sees a scientific appliance—to him, perhaps nothing more than a "machine" requiring very little human supervision—which will do the work, the judging of temperatures, better and more cheaply than a skilled workman. As a consequence, pyrometric appliances, generally of the Leeds and Northrup type, are found installed in an astonishing number of places—proportionately, to an enormously larger extent than in any English industry.

Similar considerations apply, in general, to the "routine" testing laboratory, whether chemical, physical or engineering in type. Such "control" laboratories are found almost universally, even in the smaller establishments, while the larger works have carried their development very far. In this respect, however, and in regard to the installations themselves, there is little to choose between British and American practice. The actual laboratories in both countries often leave very much to be desired. Unfortunately, there is a strong tendency, shared by both countries, to regard such laboratories as "research" laboratories, although, in fact, their research activities are extremely limited and nearly always stultified by the continual pressure of either routine work or recurrent works difficulties which are only investigated while they are acute and are then dropped, unsolved, because a different kind of trouble has arisen and calls for immediate help. In both countries it is "the laboratory"—however inadequate it may be in equipment or *personnel*—which is expected to solve these immediate and urgent problems, and it speaks volumes for the courage and patience of the men who work in such places that they often succeed in giving very valuable help, although not always on a strictly scientific basis.

The American attitude towards research of a rather higher order naturally varies widely with the circumstances of the industry and with the mentalities of the men who control them. It is probably correct to state that, broadly speaking, the business heads or "executives" of American industry are, if anything, even less technical and less scientific than the corresponding class of men in this country. One might cite as an example that, while in our own scientific and technical societies, such as the Iron and Steel Institute, the Institute of Metals and many others, there are a certain number of men of this class—heads of manufacturing concerns—who take a serious and personal interest in the work and meetings of the society, this is very rarely, if ever, the case in America. One or two exceptions—such as Dr. Matthews, president of the Crucible Steel Company of America—might be cited, but as a rule such things are left entirely to the technical and scientific men. Here the less aloof attitude of the British manufacturer is a definite gain both to British industry and to British science. As an offset, however, must be counted the really immense financial generosity which successful business men display in America towards the assistance of scientific institutions. This generosity, however, is entirely distinct, in most cases, from "business," and arises from more or less altruistic or idealistic motives. This sharp division between "business" on one side and idealism on the other is a striking American characteristic. Usually one meets with these two view-points developed in different individuals working in widely separated spheres, such as the ill-paid scientific investigator in an American college and the successful business executive. Both sides, however, do at times exist in the same individual and find expression in different activities. Even in such a man as Henry Ford, who can certainly not be regarded as a supporter or friend of science, one must recognise that co-existing with the keenest and most ruthless "business" sense, there is an idealistic side which raises some of his public efforts above the level of mere "publicity." It would, however, be a serious mistake to think that such munificent gifts as those of Carnegie or Rockefeller spring from any appreciation of the fact that science has played a part in the production of those huge fortunes; the real motive for such great gifts to science lies elsewhere.

In striking contrast to the aloofness from technical and scientific matters which has just been discussed is the attitude found in one or two special industries. The cases mentioned here do not by any means exhaust the list, but only those are referred to which came under the writer's personal notice. Three specific industries may be mentioned: the electrical, the automobile, and the photographic. The great research laboratories of the Western Electric Company and of the General Electric Company will be referred to at greater length below, and mention must also be made of the Westinghouse laboratory; here it is only desired to draw attention to the attitude of industry towards science which is manifested in those establishments. The research laboratories of the Eastman Kodak Company at Worcester, Mass., are another example. In these places there is no demand for a direct and immediate return; on the contrary, real research workers are employed at adequate salaries which attract some of the best scientific men in the United States, and they are given a wonderfully free hand. The way in which Dr. Whitney and his magnificent staff at Schenectady are given a free hand and immense resources to pursue their own lines of research argues a realisation of the proper functions of a research laboratory which is very rarely met in England. It is, of course, true that in these research laboratories a very large amount of work is done on lines laid down by the more or less immediate problems arising in the industry; but even these problems are dealt with on the broadest lines and any development which shows signs even of indirect promise is pursued. Thus the results of research are permitted to determine the direction of further research, and the fruits are literally reaped in millions. It has been said that the General Electric Company conceals more of the results of industrial research than any other corporation. In view of the immense scale of this research work, this may well be true; but the residue which is released for publication is sufficiently large and important to have won for several members of its scientific staff high places in the ranks of the world's physicists and chemists. The names of such men as Langmuir, Hull, Coolidge go to prove this point. A research laboratory almost as large, although organised on widely different lines, is that of General Motors, at Dayton, Ohio. Here very great resources are placed at the disposal of the research staff and research is far from being confined to immediate problems arising from the industry. This establishment is much younger than the great electrical institutions just mentioned, and therefore its record is not yet so imposing. The whole establishment, however, is clearly imbued with a true research spirit and great results are to be confidently expected; some—for example, the "anti-knock compounds"—are already bearing fruition. There is, of course, nothing comparable in the British automobile industry. In these establishments we see examples of the most enlightened and progressive attitude of industry towards research which the world has yet seen. In the older cases—the electrical industries—the results have already proved the business value of such a policy; in the automobile industry it is also beginning to make itself felt. It is a matter for the gravest consideration for our own industries whether they can afford to be out-distanced in this way.

The other side of this question—the attitude of the American scientific investigator towards industry—is equally difficult to define, again because it varies so widely with different individuals and in different circumstances. The true scientific investigator, in the narrower sense of the word, is everywhere a man devoted essentially, if not entirely, to the pursuit of his science mainly for its own sake. Perhaps it is a natural consequence of the intense industrialism of the country as a whole that a certain section of men of science hold themselves very strictly, almost contemptuously, aloof from the more practical sides of their subject. One finds a number of such enthusiasts, almost recluses, buried in their laboratories, often working single-handed in a year-long struggle with an abstruse problem. Such enthusiasts are, fortunately, to be found in other countries besides America, but their very aloofness is perhaps more striking in that intensely practical, industrial, fast-moving community. These men represent another branch of that highly developed idealism which has already been mentioned. Unfortunately, their semi-contemptuous aloofness is reciprocated by the more practical sections of the community, and the labours of these investigators must largely remain their own reward. In its turn this appears to have led to a general depreciation of the money value of such scientific work as is not done directly for industry, with the result that the senior teaching posts in American colleges are all relatively very poorly paid. Some American professors give the impression that they would regard it as unworthy of their calling to press for a higher financial return for their work. None the less, the existing state of affairs does not tend to raise the status of professors of science and technology; it implies not only a certain degree of sacrifice on the part of the man of science, but is apt to lead the wider public, upon whom, after all, science must depend for support, seriously to undervalue the work of these men. Work is too often valued by what it costs—which is definite and known—rather than by what it produces, which is often intangible and only indirect in its value.

It must not, however, be supposed that the aloof idealist is the only type of American man of science, or that he even constitutes the majority. So far is this from being the case that in the eastern colleges and universities particularly one receives the impression that scientific teaching and scientific research are apt to be too much under the sway of industrialism. The tendency to cater too exclusively for the needs of some important local industry is very great and leads at times to unduly intense specialisation. Thus, in one of the greatest technical institutions of New England there is an arrangement whereby a certain number of graduates in metallurgy pass—provisionally, at all events—into the employ of one of the great steel works. A resulting tendency for such students to study "steel" rather than metallurgy, and to begin this study at a stage when they should still be studying the general principles of science undoubtedly makes itself felt. This excessive and at times unduly early specialisation is favoured by another factor; this is the very strong influence which German methods of teaching have clearly exerted upon American colleges. In many instances their whole system is clearly and even admittedly based upon German models, and the strength of German intellectual influence is very considerable. While national feelings should not be permitted to influence us in the choice of the best methods of teaching or research, it is in every case necessary to consider carefully whether imitation of the methods of another nation is really desirable, since it is obviously easy to imitate mistakes. In the present connection—early and over-intense specialisation—some of the least desirable features of German technological teaching appear to have been adopted in many American colleges.

It is an almost inevitable consequence of the state of affairs just indicated that the more practical and less idealistic scientific worker in America does not long remain in the service of a university or even of such an institution as the Bureau of Standards. The attraction of industry, either of practical work in the plants themselves or at least in industrial research laboratories proves too great, and many of the most active brains and energetic characters are drawn away into the direct service of industrialism. This

tends towards a state of affairs which is perhaps of some immediate advantage to the industries themselves, but may prove of doubtful value to the American nation in the long run. This state may perhaps be best described as one in which the application of science in industry is relatively more advanced than the pursuit of science by research. It leads to a condition in which a country is quick to use what knowledge the world, including its own contribution, provides, but does not fully contribute its share of new knowledge. It is necessarily very difficult to estimate such a state of affairs correctly except in that branch of science and technology with which one is intimately familiar, and possibly metallurgical science and industry are peculiarly situated. In that very important field, however, there can be little doubt that the main current of scientific advance has not in recent years, if ever, flowed in American channels; this is freely admitted by American metallurgists, who are not slow to appreciate the contributions to scientific metallurgy which come from Europe, perhaps mainly from England. They show this appreciation in characteristic fashion by turning this knowledge to immediate practical use. Thus, while England may claim to lead in the development of metallurgical science, its practical applications have been carried much further in America. This conclusion, if just, implies criticism of both sides. Metallurgical practice in this country does not appear to value as highly as it should the scientific work done in our midst; on the other hand, it does not permanently answer for a great industry in any country to rely upon outside knowledge and inspiration, however freely given in friendly co-operation. American industry at present is favoured by so many natural advantages that it has very little to fear; natural advantages, however, do not endure indefinitely; the only really enduring asset is knowledge and skill. Under modern conditions the source of this asset is to an ever increasing extent the research laboratory. The great electrical industries of America have recognised this to the full; the metallurgical industries, on the other hand, appear so far to have failed to appreciate this vital fact.

The Hamburg-American Liner Albert Ballin.

No. I.

ONE of the most important factors in the present international shipping situation is the intensive effort which is being made by Germany to re-establish her shipping trade and to rebuild her merchant fleet. According to Lloyd's Register returns, the total German tonnage in June this year had already reached 2,496,000 tons, or nearly half the figure of 5,098,000 tons for the same month in 1914, while during last year upwards of 702,000 tons were added. When it is remembered that among the German ships surrendered under the Peace Treaty were practically all the largest and fastest passenger liners, the chief being the Majestic (ex Bismarck) and the Leviathan (ex Vaterland), it is not surprising to find that the greatest efforts in re-organisation have been directed towards replacing ships of the liner class, particularly on the North Atlantic and the South American routes. During the year the Columbus, a 32,000-ton vessel, built at the Schichau yards and a sister ship to the White Star liner Homeric, has been placed on the New York run by the North German-Lloyd Company, and in the River Plate service a notable ship is the Cap Polonio, a 21,000-ton triple-screw liner built by Blohm and Voss, which was re-purchased from the Allies by the Hamburg-South American Company. On the North Atlantic route the Hamburg-American Company has also reconditioned one of its express passenger liners and has built the Thuringia and the Westfalia, 475ft. geared turbine ships, which, along with other vessels, are running under an agreement with the United States lines. The Hamburg-American line has sought to improve its representation in this shipping combine, and to this end the Albert Ballin and her sister ship, the Deutschland, which is in course of completion, have been designed and built. This new type of ship is of particular interest, because it embodies the most recent German practice both as regards the design of the hull and the turbine-propelling machinery installation, and creates a class of ship which, in the opinion of its owners, will at least compete economically with the liners previously built, even although it falls below the largest of them in respect to both size and speed.

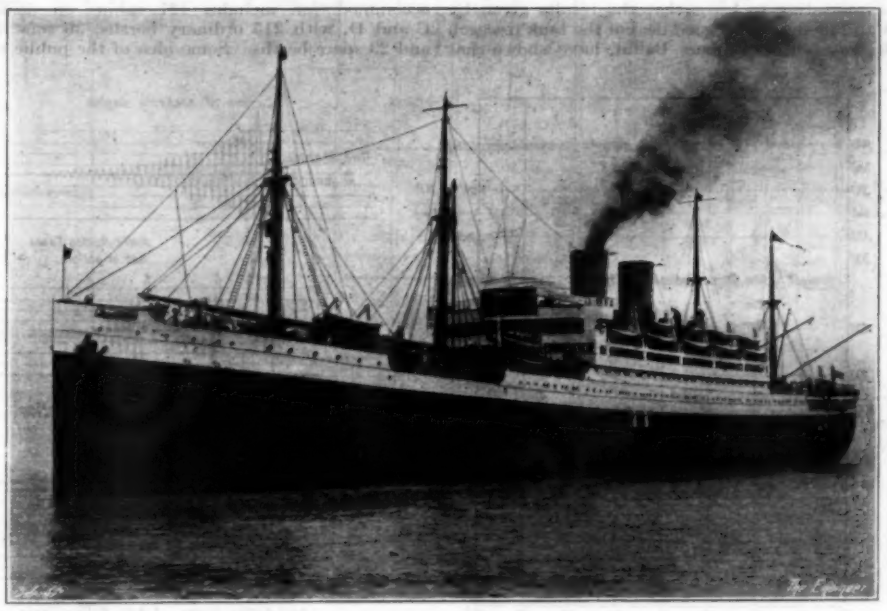


FIG. 1—HAMBURG-AMERICAN LINER ALBERT BALLIN

The outstanding feature in the design of the Albert Ballin is the application which has been made of the principle of water-line bulges, which are illustrated by the dry dock view reproduced in Fig. 3 and also the drawings on page 273. This treatment of the problem of stability was first recommended by Dr. E. Foerster for the River Plate steamers of the Hamburg-American line, in order that equivalence might

FIGS. 2 AND 3—VIEWS OF THE SHIP ON THE STOCKS AND IN DRY-DOCK

be provided for the loss in stability during the voyage brought about by the coal, oil and water consumed, by automatically increasing the stability of form. In the case of the River Plate ships, the maximum beam of the bulges coincided with the water-line on arrival. For the Albert Ballin, the same principle was adopted in order to save beam; that is, in this case, the beam required for the accommodation, being less than that necessary for stability, the latter was obtained by the principle of local bulges, while the main beam of the ship—the classification beam—remained on the practical basis of the lower figure. It is interesting to learn that the results given by the Cap Polonio, and a good deal of the tank research work done on the Albert Ballin, have shown that

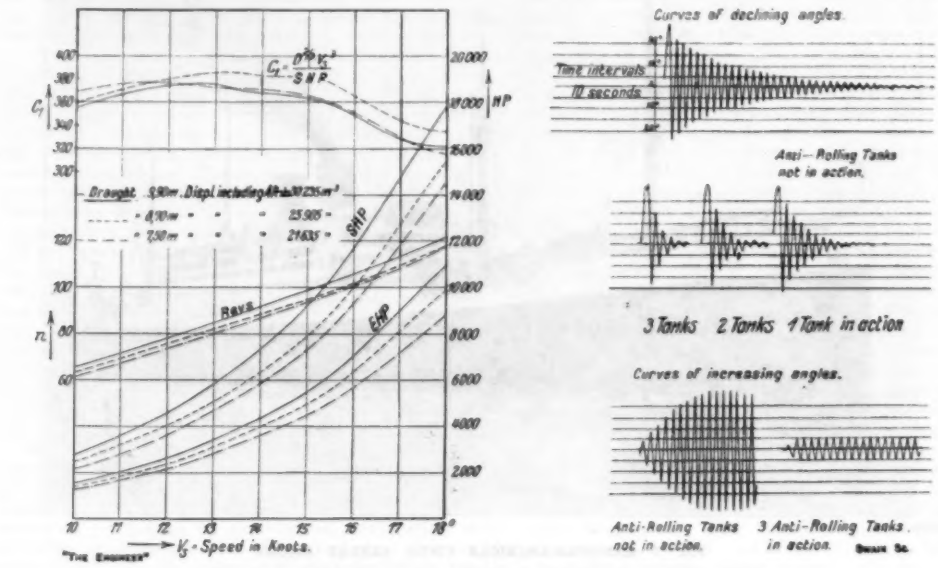


FIG. 4—SPEED-POWER AND ROLLING TEST RESULTS FROM MODEL

the resistance of a given ship is at higher speeds actually reduced when bulges are added, while at lower speeds there is practically no increase in resistance, or only a very slight one. In combination with the bulges a new system of Dr. Frahm's anti-rolling tanks is adopted, part of the bulge being used for this purpose, being made to communicate with the sea by openings in the outer hull. It may be noted that the bulges have allowed a relatively high development of the superstructure, especially in the region of the bridge decks, as is illustrated by the drawings on page 273. With these introductory remarks we may proceed to a more detailed consideration of the hull, its design and construction.

General Particulars.

The twin-screw liner Albert Ballin was built by Blohm and Voss at Hamburg, and has the following principal dimensions:—

Overall length	627ft. 3in.
Length between perpendiculars	599ft. 1in.
Breadth over inner frames	72ft. 9in.
Breadth over frames of bulges	78ft. 9in.
Moulded depth to first deck	55ft. 6in.
Height of decks	from 8ft. 2in. to 11ft. 5in.
Maximum draught	35ft. 8in.
Deadweight carrying capacity	14,500 tons
Horse-power of turbine machinery	12,000 shaft horse-power
Designed average speed	16 knots

The keel of the vessel was laid on September 24th, 1921, and in Fig. 2 we reproduce a view of the hull taken from the crane girder of the covered slipway when the superstructure was in course of erection. On December 16th, 1922, the launching ceremony took place, and on July 4th last the vessel left Cuxhaven on her maiden voyage to New York—see illustration Fig. 1. With regard to classification the Albert Ballin was built to the highest class of the Germanischer-Lloyd, and conforms to the requirements of the American, British and German shipping laws for a type of ship carrying three classes of passengers, including emigrants. The arrangement of water-tight bulkheads, of which there are thirteen in number, is shown by the thick lines in the elevation on page 273, and it will be noted from the sections given that the double bottom is carried well round the turn of the bilge. An elaborate system of hydraulic-pneumatic controlled water-tight doors is fitted throughout the ship, these being supplied by the Atlas Works of Bremen, which firm also built the electrically driven steering gear, the capstan and windlasses. Twenty-eight lifeboats are carried, including two motor boats, all of which are hung in Welin-type davits. Reference may be made to the method in which the space in the ship is distributed. The double bottom, which has a capacity of about 2300 tons, is used for the storage of ballast water, feed water and fresh water in the usual way, and a spare fuel oil tank of about 600 tons capacity is also included in this space. In addition to the double bottom tanks, further tanks outside this space are provided for fresh water and feed water, holding, in all, about 1000 tons. The main oil bunkers have been specially designed to avoid possible leakage which might be caused by deformation arising from wave action, and they have a total storage capacity of 2730 tons of oil. Altogether, the space available for cargo is 449,975 cubic feet, in addition to which there are 3038 cubic feet of refrigerated space and various store spaces amounting to another 3815 cubic feet. Turning to the passenger accommodation, the centre part of the vessel is reserved for first-class passengers, while the third and second-class passengers are distributed in the fore and aft parts of the ship. The first-class accommodation includes 127 cabins on decks B, C and D, with 215 ordinary berths, 36 sofa berths and 23 spare berths. Some idea of the public rooms may be gained by their seating capacity, which is as follows:—The dining saloon, 238 seats; hall, 64; ladies' saloon, 29; smoking room, 100; grill room, 36; children's saloon, 22; and two deck verandahs, each with 49 seats. In the second-class accommodation on D and E decks, there are 108 cabins with 216 normal berths and 124 sofa berths, while the public rooms in this part of the ship comprise a dining saloon with 214 seats, a hall with 65 seats, smoking saloon with 72 seats, ladies' saloon with 76 seats, and a deck verandah. The third-class passengers are provided for on D, E and F decks, and the accommodation includes 186 cabins with 645 normal berths and 315 berths in compartments accommodating from 10 to 30, while the dining saloon

FIG. 5—ANTI-ROLLING TANK PORTS

in this part of the ship seats 345 persons, further rooms including the smoking saloon, with 70 seats, and the ladies' saloon with equal accommodation. The sanitary equipment throughout is of the newest type.

The Bulges and Anti-Rolling Tanks.

The general construction of the side bulges and the arrangement of the anti-rolling tanks is illustrated by the sectional drawings reproduced on page 273, which also show the main scantlings of the ship, the sizes of which are given in the nearest British dimensions. In forming the bulges the principle of leading the main plating around the bulges has been adopted, with on the inner vertical frames a thinner plating of approximately bulkhead thickness. The method of constructing the windows at this part of the ship is also illustrated. Particular attention has been paid to the form of the ship where the bulge rejoins the normal hull, and necessary precautions for preserving the strength and at the same time the firmness of form have been taken. Fig. 3 shows a view taken along the hull of the ship in dry dock, and it serves to show the bulge at the aforementioned part of the ship. The arrangement of Frahm anti-rolling tanks—also shown on page 273—marks a further development in this well-known system of ship stabilisation. In the design illustrated there are three tanks on each side of the ship, which take up altogether about 60ft. of the total length of about 400ft. of bulge on each side of the hull. The three tanks are separated by wash bulkheads, which serve to restrict the motion of the water in a longitudinal direction. At the bottom of each tank there is a series of wash ports, or elongated slots, in the outer hull—see Fig. 5—which are open to the sea, and in order to allow the vessel to be trimmed by the stern, the after tanks are placed about 3ft. 3in. higher than the others. On the upper side the corresponding pair of tanks on either side of the ship are interconnected by an air passage furnished with air control valves, so that the period of oscillation of the water in the tanks may be easily controlled.

The effect of the tanks is shown by the diagram of the model tests made at the Hamburg Testing Tank, which we show in Fig. 4. The top right-hand curve shows the declining angles of the model with no tanks in action after it had been initially started with a roll of 25 deg. It will be noted that it takes about 70 seconds to come to rest. With the same vertical angle of roll the model comes to rest in about 11, 15 and 30 seconds respectively when three, two and one tanks are in action. The lower diagram shows curves of increasing angles in which a maximum roll of over 25 degrees was obtained with no tanks in action and only 5 degrees with all the tanks in action. The builders are satisfied that in service uniformly good results will be obtained, and we learn that on the outward voyage to New York, during two days of south-westerly storms, the vessel showed herself pleasingly steady. On the left hand of Fig. 5 the speed power curves for the model are given, and the form of the curves seems to indicate that the hull has been well designed for the normal speed of 15 to 16 knots. In concluding this portion of our description, it may be stated that among new navigating devices are the Anschütz self-steering gyroscopic compass and an elaborate submarine sound-signalling installation, besides the usual wireless equipment. In a further article the propelling machinery installation will be described.

Institution of Naval Architects.

No. II.*

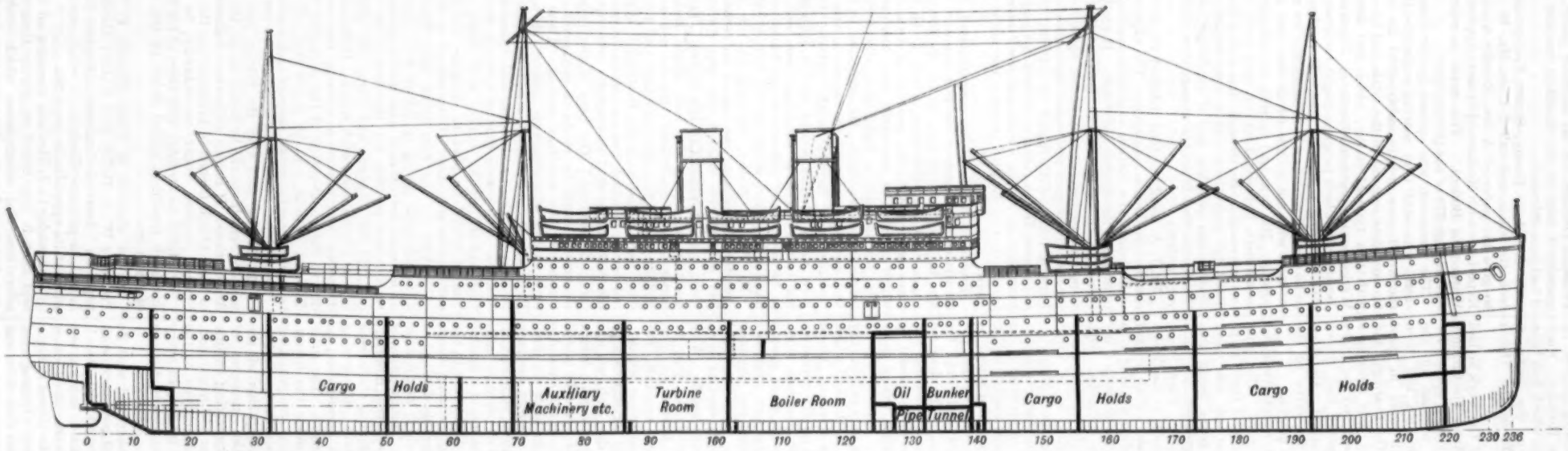
FOLLOWING the morning meeting of Monday, September 3rd, at Flushing, the members were entertained to lunch at the Grand Hotel by the Royal Shipbuilding and Engineering Company, "De Schelde," of Flushing. Dr. Jan Smit spoke of the happy relations which had existed for many years between his company and British firms. He mentioned that the late Sir William G. Pearce was connected with "De Schelde." Very cordial relations had existed over a number of years with Yarrows and also the Fairfield Company, and the association of interests had not only been the means of carrying out some very successful work, but had brought into being a most friendly feeling between the British and Dutch firms. During the afternoon the "De Schelde" yards were visited, and the well-planned and modernly equipped machine shops were the subject of much favourable comment. Several sets of turbines and gearing were seen in course of construction, and the gear-cutting plant was inspected. Among the vessels in hand is a 30-knot protected cruiser for the Dutch navy, with a three-shaft direct-driven turbine arrangement developing a total of about 65,000 shaft horse-power. The company is also building two 15-knot mail steamers for the Rotterdam-Lloyd, one of which is to be propelled by twin-screw double-geared Parsons turbine machinery and the other by two six-cylinder Sulzer type Diesel engines. The approximate total shaft horse-power for which the machinery in each case has been designed is 7000. Flushing was left at 4 o'clock on Monday afternoon for Scheveningen, which was reached about 7.30 the same evening. On Tuesday a visit to Amsterdam was made, and a large section of the members inspected the dry docks and shipyards of that famous port—we shall refer later to this visit. Other members spent the day at Volendam and Marken.

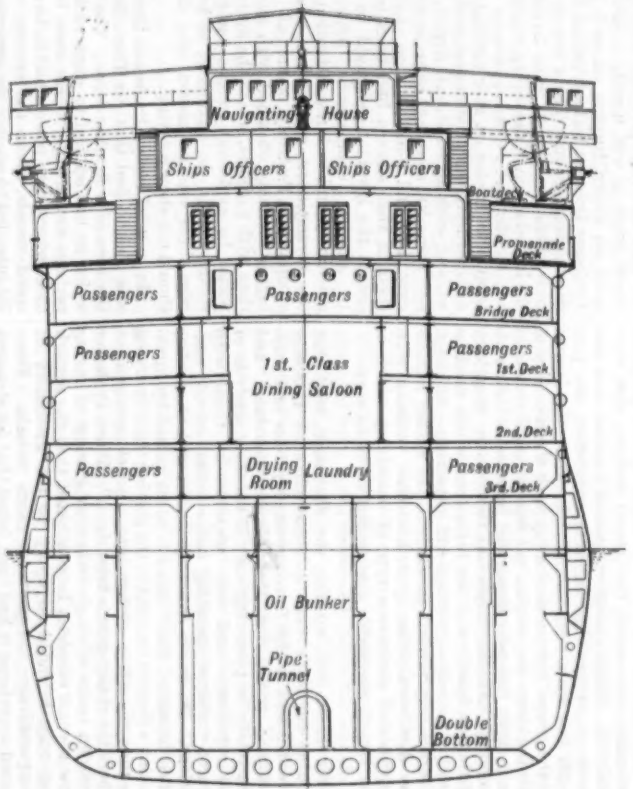
The second series of papers was read at a meeting held at the Kurhaus Hotel, Scheveningen, on Wednesday morning, September 5th. The chair was again taken by the Duke of Northumberland, who announced that a telegram from the Secretary to the Queen of the Netherlands had been received thanking the members of the Institution for their congratulations. After the names of members recommended for election

* No. I. appeared September 7th, 1923.

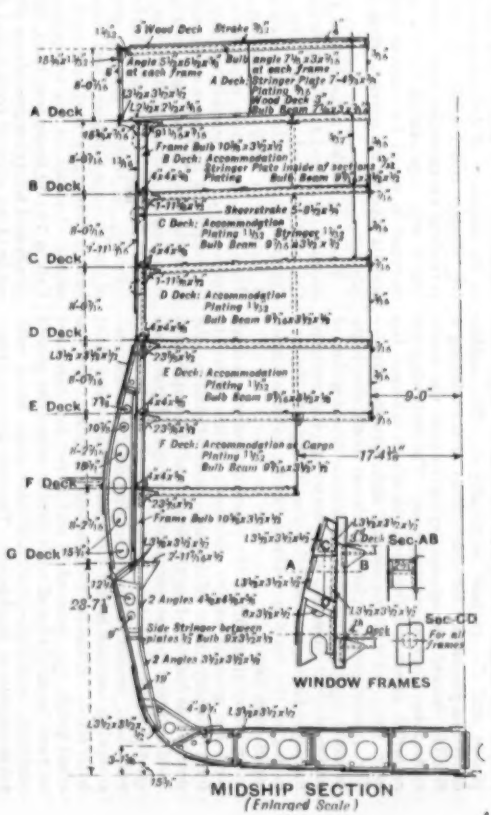
THE HAMBURG-AMERICAN LINER ALBERT BALLIN

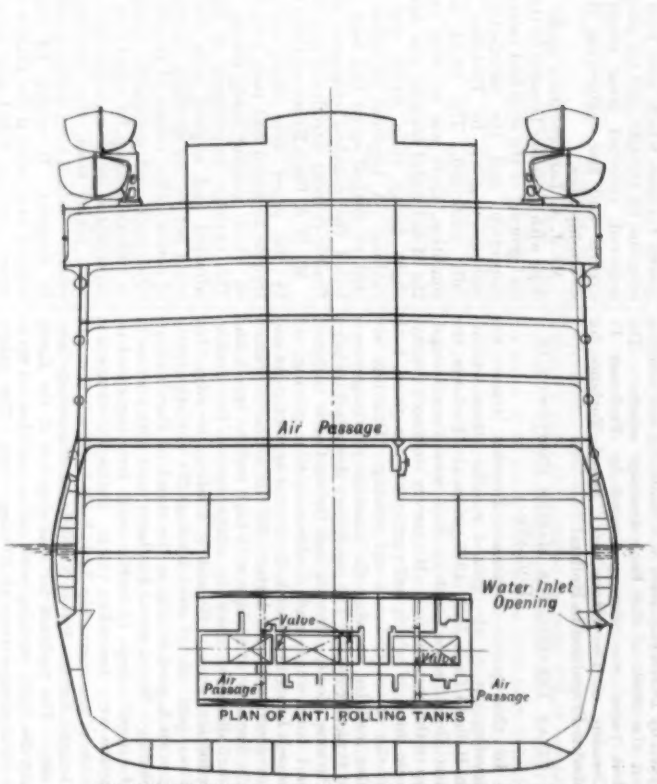
(For description see page 271)





"THE ENGINEER" SECTION AFT OF NAVIGATING BRIDGE





SECTION SHOWING ARRANGEMENT OF ANTI-ROLLING TANKS

by the Council had been read and voted upon, Mr. Francis Henderson, on the invitation of the Chairman, opened the meeting. In his remarks he referred to the similar characteristics of the Dutch and English peoples and their common seafaring and colonial interests. He recalled with pleasure the assistance given by Dutch engineers in formulating and carrying out the work of the Fens drainage scheme. The first paper was then presented by Professor D. Dresden, of The Hague, on "Steam Turbines for Marine Propulsion in Holland."

STEAM TURBINES FOR MARINE PROPULSION IN HOLLAND.

In this paper Professor Dresden traces the development of the geared marine steam turbine in Holland from July, 1915, when the Turbinia, the first Dutch geared turbine ship, was commissioned, up to the present time. His survey embraces twenty-four ships, of which full particulars are given, both of the steam turbines and gearing. Drawings are also included showing the machinery arrangements of typical vessels. The machinery described includes Parsons, Zoelly, Rateau and Brown-Curtis turbines, and both single and double-reduction gearing, six vessels being fitted with the former type of gears and seventeen with the latter. In the author's opinion the disc type of turbine with high turbine speeds and small diameter discs is advantageous for double-reduction work. Regarding blading, he says that 5 per cent. nickel steel blading did not apparently give such good results as the standard Parsons type blading. Monel metal has been used with success in the impulse type of turbine with few stages and no undue wear has taken place. Particular mention is made of the steamship Ares, built by Stork Bros., of Hengelo, for the Royal Netherlands Steamship Company. The turbines for this ship are of the Zoelly impulse type, working with steam superheated up to a total temperature of 300 deg. Cent. The blades are of Monel metal. Double-reduction gear is installed and a flexible connection between the intermediate pinion and the first wheel and between the high-speed pinion and the turbine is employed. The author expresses preference for the system of introducing a flexible element, as against trying to tune the whole system by a nodal arrangement. The following are regarded as special directions in which advance has been made in turbine design and arrangement:—The provision of astern wheels on both the high-pressure and low-pressure turbines, the adoption of underslung condensers, and better piping arrangements, which give facilities for lifting off the top casing of the turbine without having to break main steam pipe joints.

An interesting part of the paper is that which deals with the general results obtained. With regard to fuel economy, cost of repairs and reliability, the position as indicated by the reports of the shipowners would appear to be very satisfactory. Figures are quoted which show that in the case of certain single-reduction geared turbine installations the fuel consumption was not better than for similar ships fitted with triple-expansion reciprocating engines. On the other hand, economies of 16 and 25 per cent. are said to have been obtained with double-reduction geared turbines, as compared with similar ships fitted with triple-expansion machinery. The well-known advantage of non-racing in rough weather is illustrated by a series of curves which show that, whereas a reciprocating engine may reach a dangerous speed when the initial resisting torque is removed by the propeller becoming uncovered, the geared turbine, and especially the double-reduction geared turbine, does not reach an appreciably higher speed before the propeller has again been submerged. Thus the inertia of the geared system does away with the necessity of slowing down the ship in bad weather, and results in an indirect but most important increase in the ship's economy. Another important factor is the simplicity of the machinery and the little time which need be spent in periodical overhaul and inspection. Although troubles may present themselves, the author regards the double-reduction geared turbine working with superheated steam as a type of machinery which in the Dutch mercantile marine has come to stay.

Sir Thos. Bell, opening the discussion, said that marine engineers were indebted alike to Professor Dresden and to the Dutch steamship lines and shipbuilding firms, for their broadmindedness and generosity in preparing such a masterly analysis of the experience and data acquired by them with geared turbines operating under actual service conditions. He was in entire agreement with the author when he stated that "more is to be gained by introducing a flexible element in the gearing than by trying to tune the whole system into a nodal arrangement where the entire gear is kept rigid." When Professor Dresden spoke of single reduction gearing as having now become obsolete, he concluded that the remark was only intended to apply to the machinery of comparatively low-powered cargo vessels. From actual experience it had been found that for steamers having a speed of 12 knots and upwards in which over 3000 shaft horse-power per shaft has to be transmitted, single reduction gearing was preferable to double reduction gearing. The additional weight and cost of the larger turbines which were involved were fully compensated for by the smaller size of the gearing, the gear case and its lubricating arrangements. Furthermore, the mechanical efficiency of single reduction gearing was slightly higher, and the resistance to rotation of the astern turbine was slightly less for the slower running high-pressure turbine. It was gratifying to hear the favourable opinions on geared turbines which were held in Holland. Such opinions, he thought, and the success which had been achieved, reflected great credit on the technical experts and the engineering staffs of the Dutch steamship lines.

Mr. J. A. Lambrechtsen spoke of the work he had done with Professor Dresden on the Ares. The turbines and gearing of the ship had recently been opened for inspection, and the satisfactory account of the machinery given by Professor Dresden had been fully confirmed. The wheel teeth were in good condition, there was no wear on the bearings, and the Monel metal blading was intact, only showing a slight brown stain which was removed by light rubbing. A torsional vibration meter had shown that no critical speed had been reached. He attributed the noiseless character of the drive to the flexible element introduced into the gearing.

Mr. H. A. Ruck Keene said that the results described by the paper were most satisfactory. The only trouble he noted had been with the first three ships on which gearing made during the war was used. The extreme importance of all gears being cut, adjusted and aligned with the greatest precision could not be too strongly emphasised. There were, of course, other causes of trouble, such as inefficient lubrication and unsuitable materials. With regard to turbine blading, he noted that when working with superheated steam corrosion had occurred with 5 per cent. nickel steel, this experience coincided with results obtained from similar blading in turbines made in England. It would, he thought, be of great interest and value if the makers and users of marine steam turbines would give some further expression of their opinions as to the best blading material to use for different types of turbine and under various steam conditions. The author had rightly drawn attention to the necessity of designing the turbines so that the top casings could easily be opened and lifted for periodical examination and overhaul. The diagram which was reproduced in the paper, showing the increase in speed for various types of reciprocating and turbine prime movers when racing, was of great interest.

Mr. R. J. Walker remarked on the very satisfactory account of geared turbine practice in Holland which the author had given. The Rotterdam Lloyd Company was to be congratulated on the initiative it showed in 1915 by building the Turbinia when there was but little experience with such geared machinery. He considered that the two essentials for successful gearing were sound steel and accuracy in workmanship and gear cutting. The latter had been highly exemplified in the work seen at both the de Schelde and at the Werkspoor works. With reference to turbine blading material, the practice of the Parsons Company had always been to use non-ferrous blades, so that corrosion was avoided. For saturated steam or for temperatures below 400 deg. Fah. a 70 : 30 brass was used, while for superheated steam and temperatures above 400 deg. Fah. use was made of an alloy of copper and manganese. Astern turbines had been mentioned, and it might be stated that the British practice was to fit, in the case of a single screw ship, astern turbines in both the low-pressure and high-pressure units; whereas for twin screw work it was usually considered sufficient to have an astern turbine on each low-pressure unit. Professor Dresden had advocated the use of a flexible driving connection. There was no doubt that in the case where two pinions were driving the same wheel, the introduction of flexibility considerably diminished any shocks and excessive stresses which might arise from inaccuracies on gear cutting. The majority of marine turbine installations ran perfectly well, however, without such an additional device, and as there were now some 500 merchant ships in service, representing over two and a-half million shaft horse-power, he thought that success had been proved. The more simple the installations could be made the better. In making comparisons between reciprocating machinery and turbines, attention should be paid to the arrangement and steam consumptions of the auxiliaries. Probably some of the instances of higher economy obtained with reciprocating engines than with turbines, which the author had mentioned, would be explained were a careful analysis of the steam used in the auxiliaries to be made. In every case there was no reason why the geared turbine should not show a saving.

In a brief reply, Professor Dresden said that he was glad to find that Sir Thos. Bell concurred with the idea of a flexible drive. The word "obsolete" which he had applied to single reduction gearing was perhaps too strong. There were, he concurred, often cases where large powers had to be developed in high-speed vessels, where the system was advantageous. He intended to convey the impression that there was no reason to be afraid of double reduction gearing. Auxiliary machinery undoubtedly exercised an important influence on the overall economy of a ship. In the case of the Ares, existing auxiliaries which were perhaps too large had been used partly with the idea of enabling the attention of the operating staff to be devoted chiefly to the main turbines. It was a pleasure for him to help in any way to lift the cloud which during the last year or so had seemed to overshadow the geared turbine.

The Duke of Northumberland then thanked Professor Dresden for his valuable paper, and congratulated him on the excellent manner in which it had been delivered.

Sir Archibald Denny, Senior Vice-president, then took the chair and called upon Mr. W. J. Muller to give his paper—"A few Results from Practical Experience with Mechanical Stokers Applied to Marine Water-tube Boilers." This paper is reproduced in full on page 279 of our present issue.

The discussion was opened by Sir John Thornycroft, who said that marine engineers throughout the world were greatly indebted to the author, for his complete account of the trials and his experience with this type of stoker, which had been seen at Werkspoor the previous afternoon. There was another direction in which progress might be made, and that was by using pulverised fuel. If bunker coal had to be treated to reduce it to small size for mechanical stokers, why not go the whole way and grind it to powder. His firm had carried out extensive experiments with pulverised fuel on trial boiler with satisfactory results. He thought that with a Scotch boiler fitted for pulverised fuel a considerable degree of control was possible, and if combined oil and coal fuel fronts were fitted the change over could be made very quickly.

Mr. J. A. Lambrechtsen thanked the author in the name of his Dutch colleagues. The experiments described marked a further step in the application of the principle of the mechanical stoker. It would be of interest to those present to learn that the Dutch shipping lines had recently jointly appointed an engineer to investigate and report upon new methods of burning fuel. With regard to reducing the number of firemen, Dutch practice allowed one man to attend from four up to six furnaces if small ones. He believed that in English practice three was the maximum.

Professor W. E. Dalby congratulated Mr. Muller on the completeness of his test figures. Two years ago he had pointed out, when discussing a boiler paper, that the efficiencies usually given in trial returns were really the product of two efficiencies, which should be separated and analysed; these were the furnace, or combustion efficiency, and the transmission efficiency. He suggested to the author that he might examine his figures in this way and, perhaps, new factors would present themselves. How many stokers would such a system release? He could not help thinking that were the fuel to be completely pulverised and burnt as dust the number of stokers would be still further reduced.

Mr. W. J. Muller, replying to the discussion, said that as regards the use of pulverised fuel, he had studied this matter, but was convinced that there were drawbacks to this system. One was the question of drying the fuel, which became acute under tropical conditions. He did not see how this difficulty could be easily overcome. [Sir John Thornycroft here stated that the Bettington type of aero-pulveriser, in which hot air was made use of to dry the fuel, would deal successfully with up to 10 per cent. of moisture.] The bars in the type of grate illustrated could be made of any good cast metal because of the excellent cooling. There had been little trouble with removing clinker. He agreed with Professor Dalby that it would be more scientific to separate the combustion and transmission efficiencies. The reason that he had not done this was that exactly similar boilers were being compared, but he would be glad to compare the figures for combustion efficiency. With regard to the number of stokers in the four-boiler ship Swartenhondt, a considerable saving in labour was expected with an ultimate reduction of nine native stokers. It had been found possible for the fireman to break the coal, fill the hoppers and dump the clinker three or four times during each watch. If the experiments described had proved a success, this was largely due to the co-operation of the engineers of the two different nations, and he hoped that efforts would be made to continue and improve such a policy.

Sir Archibald Denny, in proposing a vote of thanks to Mr. Muller, said that the matter just discussed was one which should be taken up by the Research Associations. If British shipowners followed the lead of their Dutch friends in investigating this question, further progress would, undoubtedly, be achieved.

Mr. Muller had frankly told them of his difficulties, and such frankness added much to the usefulness of the paper.

In the absence of Lieut.-Colonel F. Modugno, Professor W. E. Dalby gave a short abstract of the paper on "Internal Combustion Engines Exhausting into Low-pressure Turbines," which we reproduce without its appendix on page 290.

Commander C. J. Hawkes, speaking on this paper, said that it was based on purely theoretical considerations and assumptions, which could be discussed at great length. He noted that the author had not referred to Junkers' 200 horse-power compound engine. The system advocated in the paper was virtually akin to throttling the exhaust, which would have the effect of raising the temperature throughout the cycle, and probably of increasing the fuel

consumption. He thought that in practice the 4 per cent. saving referred to might vanish and even, perhaps, appear as a loss. The system described would also add complexity, and what was wanted was simplicity and low cost. If such a method was accepted, there could be no advantage unless supercharging was used, and he doubted whether the system was economically a sound one. In the case of the two-stroke cycle engine, a scavenge pump was necessary, and it might be more advantageous to use the heat of the exhaust gases to raise steam and operate a steam-driven scavenge blower.

The chairman thanked the author for his contribution, which, he stated, would certainly stimulate thought and discussion.

The last paper was that by Professor William Hovgaard on "The Theory of Bending." In the absence of the author it was presented by Mr. W. J. Luke, who gave a short abstract of its contents. We give in the following a *résumé* of the paper.

THE THEORY OF BENDING.

By Professor WILLIAM HOVGAARD.

The problem of calculating the strength of girders which are built up from materials with different moduli of elasticity has become of great importance in recent years; first, as a result of the introduction of reinforced concrete and, secondly, in connection with the design of airships. In concrete beams the steel bars are embedded in the concrete, so that the bond resistance compels them to work together. In semi-rigid airships a keel girder of steel or duralumin is suspended from the lower part of a fish-shaped envelope made of a fabric of relatively low modulus of elasticity, but the two component parts of the structure, although separate, are closely connected and forced to deflect together. It was by a study of the latter problem, as also that of the strength of rigid airships, that the author was led to inquire into the limitations of the bending theory and to make an attempt to place it on a broader foundation. It was hoped in this way to prove that the bending theory may be safely and simply applied to girders of rather irregular structure, even when their component strength members are not of the same material. The investigation led to what is believed to be a new and fundamental proof of the essential soundness of the theory, justifying, moreover, its extension to beams of non-homogeneous materials.

It is generally conceded that if a beam is homogeneous and perfectly elastic the ordinary bending theory applies to the case of simple bending even when the transverse sections vary, provided they vary in a continuous manner and not too abruptly. In practice, bending is almost invariably associated with and produced by shearing, but still the theory is used to find the bending stresses, in general regardless of the way in which the bending moment is applied. In most cases the shearing stresses may be calculated independently and compounded with the bending stresses without great error. Strictly it is assumed in the bending theory that the bending is produced by tractions distributed over the terminal sections of the beam in a particular manner; but, as shown by Saint-Venant, when the length of a beam is large compared with its transverse dimensions, the state of stress and strain created by terminal couples is practically independent of the mode in which these couples are applied, except quite locally near the ends. This principle probably applies also to non-homogeneous girders, with the qualification that here the adjustment of strains and stresses will extend to a greater distance from the ends before an ideal *régime* is established.

In the proof of the ordinary theory of bending it is assumed that transverse sections which are plane before bending remain plane after bending, which in homogeneous materials is equivalent to saying that the stresses as well as the strains are proportional to the distance from the neutral axis. Saint-Venant has shown that under certain suppositions this assumption is justified as an approximation to the first order for beams of homogeneous materials, but for non-homogeneous materials it is not known to have been established theoretically, although it is generally accepted for beams of reinforced concrete on the basis of experiments. In the present paper it is attempted to show that for non-homogeneous as well as for homogeneous materials the assumption is in accordance with the Principal of Least Work, whereby the theory is placed on a simple incontrovertible basis and it is rendered more easy to discern its limitations. If this solution is accepted the difficulty of the above-mentioned "Saint-Venant's Problem" disappears, since there is then no necessity for assuming a particular distribution of the forces which constitute the terminal couples.

Consider a horizontal fairly slender beam in equilibrium under the action of terminal forces which produce a uniform bending moment in the vertical plane. The forces acting at the ends are so adjusted as to produce no body forces and no shear except very near the ends. An elemental transverse disc of the beam is enclosed between two transverse sections at a small distance apart. On the elements of area of each section act normal stresses, which under the given conditions have no axial resultant, but form a resisting couple which balances the bending moment. The distribution of the stresses is supposed to be unknown and no assumption is made *à priori* as to the existence or location of a neutral axis. The modulus of elasticity may vary in any manner between contiguous longitudinal filaments of the disc.

It is now argued that the stresses and strains must tend to adjust themselves so as to conform to the Principle of Least Work. When this principle is applied to the problem with the aid of the Calculus of Variations the result obtained is that, under ideal conditions, where the strains and stresses have had an opportunity to adjust themselves outside the disc in such a way that the elastic potential is a minimum in the disc, the strains, but not necessarily the stresses, must be proportional to the distance from the neutral axis. The formula for bending then takes the form

$$\frac{p}{y} = \frac{M}{\mu I}$$

where μ is the ratio between the modulus of elasticity E_0 of a certain material adopted as a standard and E_1 that of the material of the filament under consideration. In the calculation of I the area of the material, which has the modulus E_1 is divided, by μ. In other words, the moment of inertia is calculated to the standard of the material of modulus E_0.

Professor Dresden pointed out some apparent contradictions, and was followed in the discussion by Mr. C. S. Baker, who said that work on composite structures had caused similar investigations to be instituted at the National Physical Laboratory. Practically the same assumptions had been made, and it was hoped that a mathematical method would be evolved by means of which the various conditions obtaining in a composite structure would be fully taken into account. With experimental test pieces made up of mahogany and pine it was found impossible to prevent slip from taking place between the pieces. The question of transverse bending was a complication which had to be faced.

The chairman thanked Mr. Luke for introducing the paper, and the meeting was then closed.

It is difficult to compress into a few words any adequate account of the remarkable series of visits arranged by the Reception Committee. It included visits to shipyards and engineering works, excursions to picturesque parts of Holland, and the viewing of historical buildings and museums. On Tuesday, the 4th instant, Amsterdam was visited and the main party, accompanied by the president, the Duke of Northumberland, made a tour of the chief shipbuilding, repairing establishments, and engine shops of that famous port. A smaller party of members spent the day at Volendam and Marken. The first yard to be inspected was that of the Amsterdam Dry Dock Company. The firm was established in 1877, and the original iron floating dock of 4000 tons lifting capacity, built for the company, was seen in use, as well as the other 4000, 7500, and 16,500-ton floating docks which have since been added. Last year a new floating dock of 25,000 tons capacity was ordered from the Netherlands Shipbuilding Company. Considerable interest was displayed in the Linde oxygen plant and the variety of repair work upon which the various shops were employed. The three graving docks of the Netherland Dock Company on the nothern bank of the North Sea Canal were next inspected. The construction of these docks, with the adjoining yard, which has an area of about 47 acres and a water frontage of over 2000ft. for large ships, was an engineering task of no mean order. The docks themselves are built in concrete laid on a piled foundation. Electrically operated steel gates are used, which open and close in two minutes. The pumps are grouped in a special pump-house and are made interchangeable for all the docks. For No. 1 dock four centrifugal pumps, each driven by a 250 brake horse-power motor and having a capacity of 120 cubic metres per minute, are provided. The main particulars of these docks are as follows:—

Dock No.	Length on floor.	Depth over blocks.	Breadth of entrance.
1	640ft.	29ft. to 30ft. 6in.	88ft. 6in.
2	515ft.	21ft. 6in.	72ft.
3	437ft. 6in.	19ft.	65ft. 6in.

The whole plant was designed with a view to doing quick repairs. The machine shops are well equipped and excellent crane facilities are available both in the ships' storeyards and alongside the graving docks. On page 282 we reproduce some views of the new yard of the Netherland Shipbuilding Company, which is also situated on the North Sea Canal. The slipways, of which three are now completed, are capable of accommodating vessels up to 1000ft. in length. They are laid on concrete floors resting on piles, and are so designed that two slips can be combined for the building of floating docks. This particular use of the slipways was shown during the visit, when several sections of the new 25,000-ton Amsterdam Dry Dock Company's dock were seen. When vessels are under construction the slipways are shut off from the harbour by large caissons, which are only removed when a vessel is launched. In order to facilitate launching operations the inclined concrete floors are extended under the water to a depth of 15ft. at the outer ends. As will be seen from the illustrations we reproduce, gantries have been erected on both sides of the building berths to a height of 87ft. They each carry two lifting cranes having a capacity of 3½ tons each, designed to lift material to a height of 120ft. Underneath the top part of the slipways there are spaces for stores and for the electrically driven air compressing plant. The shops themselves are built close up to the inner ends of the berths and the storage and handling of the material has been carefully considered. The shop equipment is notable for the large electrically operated machines, which have been mainly supplied by German firms. We noted three one-man punching machines, by Schiess and Sack, and a 3½ m. shear, while a 32 multiple-spindle drill by Schiess was seen in operation. This machine is capable of drilling eight plates each of 11 mm. in thickness. After inspecting the yard and shops the visitors were entertained to luncheon at which a welcome was extended to them by Mr. D. Goedkoop. The Duke of Northumberland replied in appropriate terms.

In the afternoon the old yard of the Netherland Shipbuilding Company was visited, where a considerable amount of work was seen in progress, including several cargo and passenger ships and the Dutch cruiser Sumatra. Two of the most recent orders are for motor oil tankers for Norwegian owners. They will have a length of 469ft. and about 12,800 tons deadweight capacity, and the propelling engines will be of the Werkspoor marine Diesel type developing a total of 3600 shaft horse-power on twin screws. These tankers will be built on the Miller system of framing, for which it is claimed that it provides the most scientific structural construction yet applied to hull design. The top and bottom of the ships are framed longitudinally, giving increased sectional area at the points of greatest stress when the vessel is subjected to severe bending stresses in a seaway. The sides are stiffened vertically, which ensures the fullest development of the material in the upper and lower members and gives a maximum longitudinal strength to the structure. One of the interesting features of this yard is the series of overhead floating cranes which serve the punching machines. The crane float travels in a shallow overhead tank filled with water, and a very flexible and easy lift is obtained.

Adjoining the old yard of the Netherland Shipbuilding Company are the famous engine works of Werkspoor. One of the main objects of interest in these shops was a set of Babcock-Wilcox marine boilers with underfeed automatic stokers for the ss. Swartenhondt. The stokers were shown in operation, and they are described in Mr. W. J. Muller's paper, reproduced on page 279 of our issue to-day. In the locomotive shops were several of a series of 20 goods locomotives with large cylinders and extra heavy rods which are being built for the Netherlands railways. When the damaged portion of the works resulting from last year's fire is completed in a few weeks time, this shop will be considerably extended. A large amount of sugar mill work for Java was seen going through the shops, and one of the mill engines, with a new type of oil relay governor, was shown in operation. At the time of the visit the new orders for Werkspoor Marine Diesel engines were not far enough advanced to permit of engines being seen in the workshops, but an experimental four-stroke double-acting engine was shown, and also a smaller Diesel engine working with solid injection. Other work in progress comprised a number of marine engines and geared turbines.

In the afternoon on Wednesday the ship decoration works of H. P. Mutters and Son in the Hague were visited, and in the show rooms of this famous firm of Dutch furnishers some fine examples of interior decoration were seen. Several scale models of decorative schemes were exhibited. Noteworthy among the finished work shown was some panelling for the new Staten Dam of the Holland-America Line, which is being built by Harland and Wolff at Belfast, and some fine examples of coloured wood inlaid panels for one of the Dutch passenger liners. On Wednesday evening a reception was held at the British Legation in the Hague, and the members of the party were received by Sir Charles Marling, the British Minister, and Lady Marling.

The first visit to Rotterdam took place on Thursday morning, when the main party was led by Sir Arch. Denny. Some of the party spent a pleasant day at Leiden and the Lake District of Holland. The first works to be seen on Thursday were those of the noted Werf Gusto—Firma A. F. Smulders—whose cranes have a world-wide reputation. Unfortunately only one large crane was going through the shops, but several dredgers barges were on the slipways, and some smaller work was going through the shops. The chief interest centred on the 200-ton self-propelled derricking and revolving floating crane, which is now ready for delivery. This crane is similar in construction to that supplied to the Mersey Docks and Harbour Board at Liverpool, which was described and illustrated in THE ENGINEER of October 15th, 1920. Leaving Werf Gusto, tugs conveyed the party across the harbour to the Rotterdam Dry Dock Company's yard, where a considerable amount of repair work is being done. This extensive and well-planned yard, with its three floating dry docks of 5000, 8000 and 15,000 tons lifting capacity, is one of the most noted of Rotterdam's industrial undertakings. The artistic model village built by the firm was also inspected. Although repair work was well in evidence, only one new ship was seen on the berths. This was a motor tanker of 7000 tons deadweight capacity, which is being built on the Miller system. The bottom shell, the centre guider and sections of the middle line bulkhead were in position, and other parts of the framing and plating were being prepared for erection. During the visits to the various Dutch yards much attention was attracted by the one-man automatic punching machine, as developed by German firms, and at the Rotterdam Dry Dock Company a new British type of machine, which is capable of being applied to any existing punch, was seen in operation. The plate traverses the front of the punch in a lengthways direction, and it is supported on rollers which run on ball bearings and are actuated by bevel gearing with a chain drive. Movement of the plate in a crosswise direction is obtained by a worm drive. The operator sits above the plate immediately in front of the punch head, where he is in a position to control all movements. The machine demonstrated the possibility of punching 19 holes per minute in a shell plate. The gear for operating the table movements has been developed by Mr. D. C. Endert, jun., director of the Rotterdam Dry Dock Company, and the machine is covered by patents held by Mr. Endert and Mr. H. W. Curchin, the managing director of the Miller system of ship construction.

Luncheon was given by the New Waterway Shipbuilding Company at its shipbuilding yard and engine works on the Maas, where the party received a cordial welcome from Count and Countess Van Heerdt tot Eversberg and Mr. P. F. Nicholson. Established in 1914, and laid out and built under great difficulties, seven building berths have now been completed, and since 1918 some fourteen vessels, varying from 7200 to 12,500 tons, have been constructed. The repairing plant is very complete, and three floating dry docks, one of 13,500 tons and two of 4300 tons lifting capacity, were seen in use. In one of the latter docks a small 1000-ton vessel—the ss. Holland—

was seen. She was built for the United Netherlands Steamship Company's tropical service in six months and one week.

Returning from the New Waterway yard to Rotterdam, a brief glimpse of the new Wilton Yard, with its 46,000-ton floating dry dock, was obtained. Some time was spent at the old Wilton yards, where all departments were busily engaged in repair work, and the large forging press was shown in operation. The party was shown round by Mr. J. H. Wilton, after which tea was served. A further visit to Rotterdam was paid on Friday morning, when the Nautical and Technical Museum was inspected, the party being received by Rear-Admiral Dunlop, Baron van Haersolte and his staff. This unique institution and its work was described in our last issue. Another works and shipyard, which was seen at Rotterdam, was the new establishment of Burgerhouts Engineering and Shipbuilding Company. This firm was founded by the grandfather of the present managing directors, and at the old yard on the Zalmhaven produced steam engines and boilers for many years besides carrying out ship repairs. The new yards and shops are equipped with the most modern machinery and appliances, and recent work included a 200ft. long dredger—Foremost—for dredging up to 75ft. in breadth, which was built for the James Dredging and Towing Company, of Southampton, for work on the new site for the floating dock. During the year an 8000-ton floating dry dock for the Tandjong Priok Company was completed, and another 4000-ton dock for South American owners is under construction. The firm is also undertaking Diesel engines, and an 800 H.P. two-stroke marine engine of the Nobel type is to be built. After viewing the works the party was entertained to lunch by the Burgerhout Company. Another section of the party was shown round the Rotterdam Harbour in the Holland-America Company's steamer Columbus, and was entertained to lunch on the Rotterdam-Lloyd mail steamer Insulinde. In the afternoon a reception was held at Scheveningen by the Koninklyk Institut van Ingenieurs, the members of which body had previously met to hear a paper on "Boiler Feed-water Circuits in Power Stations," given by Mr. James Weir, of Glasgow. We hope to refer to this paper in a subsequent issue. The dinner given by the Institution of Naval Architects to the Reception Committee in Holland, took place at the Kurhaus Hotel, Scheveningen, on Friday evening, when the Duke of Northumberland presided over a large company. After the loyal toasts of "The Queen of Holland" and "The King" had been honoured, Sir Charles Marling, the British Minister of The Hague, proposed the toast of "Shipping and Shipbuilding in Holland," which was replied to by Mr. B. E. Ruys and Mr. J. R. Lambrechtsen. The Duke of Northumberland expressed, in a happy speech, the deep indebtedness of the party to the Reception Committee, and looked forward to the time when the Dutch friends would visit England. Replies were made by Professor S. G. Everts and Dr. A. G. Kröller (the President of the National Committee of the Nautical Institution and Museum), and a brief closing speech by Sir Archibald Denny was made. On Saturday morning the members of the party left Scheveningen for Flushing, and travelled to Folkestone by the Zeeland Steamship Company's steamer Prinses Juliana, Baron van Haersolte and Mr. S. van Hoogstraten again accompanying the party. A calm and fast passage was made, and London was reached shortly before eleven. By the courtesy of the Rotterdam-Lloyd Company certain members of the party were taken from Rotterdam to Southampton on one of the company's outgoing liners.

The 1923 visit of the Institution of Naval Architects to Holland will long be remembered as outstanding among many happy summer meetings, and by it we are sure that the good relations existing between the two countries have been strengthened and many friendships made and deepened.

THE spell of glorious weather experienced during the first fortnight of July began on Wednesday, the 4th of that month. On the afternoon of the following day a passenger train was derailed at Culver Junction on the Lewes-Eridge branch of the Brighton section of the Southern Railway, owing to distortion of the road, primarily due to the high temperature. Major Hall has just reported on this accident, and from his report it is seen that there was sufficient evidence to show that the interval of time between the distortion of the road and the arrival of the train must have been very short, and may quite probably have been almost momentary. Major Hall found that the section of road appeared to be particularly well maintained, but that there was excessive friction at certain of the joints, probably due to their having been a little rusted up. He said, in concluding his report: "This case emphasises the necessity for sufficient freedom of movement at rail joints to enable the rails to expand without undue compressive strain. It is common, and, I think, sound, practice to encourage this movement by the use of grease or its equivalent between rail and fish-plate. This obviates any risk of the rusting up of the joints and undue friction between the fishing angle of the plate and the rail, which, with untreated joints, may result even where bolts are not unduly tight. I understand that instructions have recently been issued for the greasing of fish-plates to be carried out in hot weather conditions throughout the whole of the Southern Railway."

The Shipping, Engineering and Machinery Exhibition.

No. III.*

AMONG the electric truck exhibitors are British Electric Vehicles, Limited, of Churchtown Works, Churchtown, Southport. One of the exhibits is a super-sprung giant truck on semi-elliptic springs. The truck has been specially designed to meet the requirements of some of the company's clients. The other exhibit is an electric locomotive with a capacity of 2 tons 15 cwt. This type of locomotive is now used on an extensive scale in iron mines, and the vehicles have also recently gained the favour of contractors. The locomotive is being used, for example, in connection with the London tube extensions and the construction of the new London County Council main sewer. On the City and South London Tube extension the locomotive is said to save about 10s. per hour.

L. Gardner and Sons, Limited, of Barton Hall Engine Works, Patricroft, have a number of heavy oil and petrol engines ranging in output from 4½ horse-power up to some 30 horse-power, the general construction of which is familiar to our readers. There is also on this stand a new design of cold-starting heavy oil engine, shown in Fig. 26, capable of developing from 29 to 31 brake horse-power when running at 250 revolutions per minute. The lubricators fitted on these engines are specially noteworthy and are so devised that each point to be lubricated is served by a complete and separate unit consisting of a double-ram pump with its pair of actuating levers. The lower pump measures the charge of oil and delivers it, by way of a sight-feed nozzle, into a well situated over the inlet of the upper pump, into which it flows by gravity and suction. The upper pump then forces the measured charge to the part which requires lubrication. Each double pump, which is formed in one piece, is readily and separately detachable from the lubricator box. The sight-feed nozzles are totally enclosed in a chamber having a transparent wall. The upper pump ram with its actuating lever has a constant stroke, but the lower pump ram stroke can be adjusted by means of a screw. The pump valves are steel balls with special provision for withdrawing them for examination or cleaning.

Sprecher and Schuh, of 212a, Shaftesbury-avenue, are exhibiting switchgear, &c., for transmission lines. The transformer cabin shown in Fig. 29 has been designed for fixing at the top of transmission line poles. The cabin is composed of sheet iron, and the transformer, which need not be of the outdoor type, protrudes through the base of the cabin, the terminals being protected against atmospheric influences. The high-tension line terminates on the cabin in high-tension bushings, consisting of a porcelain insulator and a connecting bolt, which leads the current to the interior of the cabin. The primary side of the transformer is protected by three high-tension expulsion type fuses, whilst the secondary side and the distribution lines are equipped with fuses of the porcelain handle type. The low-tension leads are taken out of the cabin through suitable porcelain pipes. Doors on either side of the cabin give access to the interior, and a folding platform, with a safety rail, enables the workman to carry out his duties without danger. Above the cabin the lightning arresters are fitted. They consist of horn type spark gaps in combination with earthing resistances. Preferably, the latter are made of carbon rods contained in an earthenware protecting tube. The line-sectioning switch—shown in Fig. 30—is

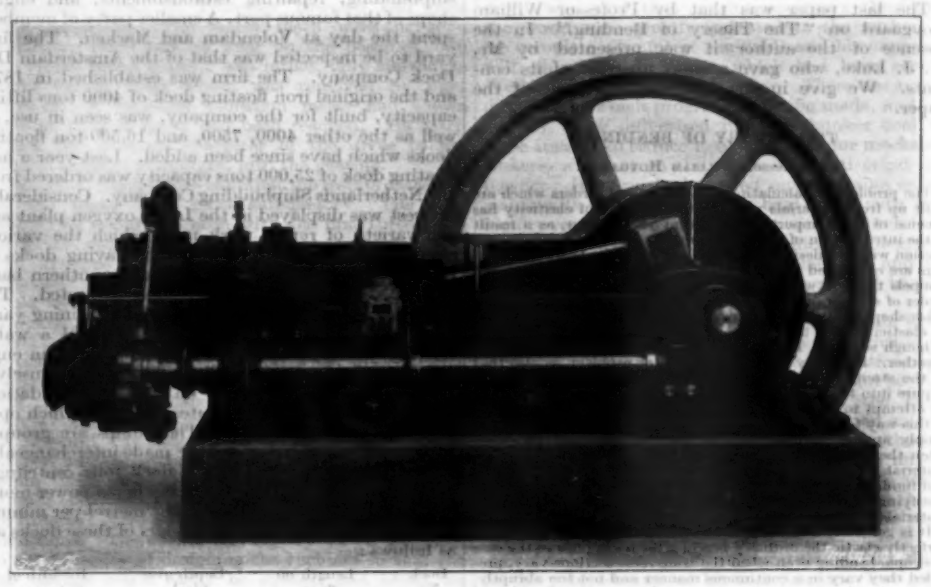


FIG. 26—GARDNER COLD STARTING HEAVY-OIL ENGINE

FIG. 27—REMOTE CONTROLLED OIL SWITCH

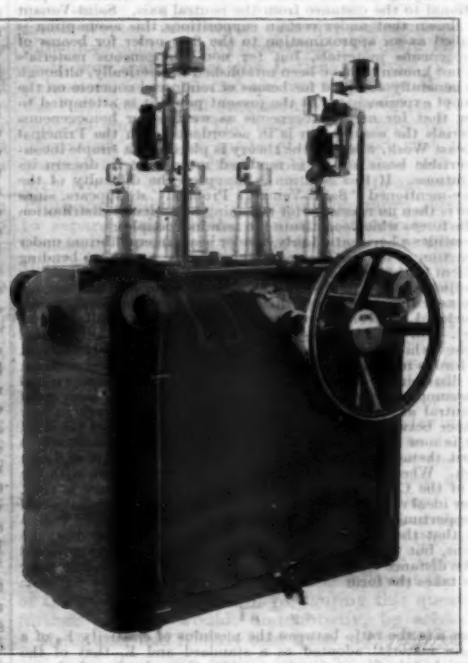


FIG. 28—OIL SWITCH

* No. II. appeared September 7th.

of the horn type, with a carrying capacity of 200 ampères at 12,000 volts, and it is capable of breaking this current at the full voltage with perfect safety to the operator and without danger to the switch itself. The framework consists of tubes which are held together by mechanical clamps. The operating lever is contained in a cast iron case fixed so as to be within easy reach of the operator The cover of

FIG. 29—TRANSFORMER CABIN

this case is locked by means of a padlock, so as to avoid the possibility of the switch being operated by unauthorised persons. The connection between the operating lever and the switch is established by an iron tube, and the apparatus is, therefore, immune from wilful damage. The operating handle is locked by a hinged cover in its two extreme positions of "on" and "off," so that the switching operations must be completed before the operating mechanism can be closed. The switch cannot, therefore, be left in an intermediate position. This is a matter of great importance, especially as these switches frequently have to be operated at night. The current-carrying parts of the switch are composed of brass and copper, and with the exception of the horns, they are nickel plated so as to resist the corrosive effects of the weather. There are also some oil switches with large breaking apparatus, as shown in Fig. 28. One of these switches is fitted with a direct-acting overload release, whilst others are fitted with electrical remote control gear. The oil tanks have curved sides so as to give the necessary resistance strength to withstand internal pressures. A remote-controlled oil switch is shown in Fig. 27. Another notable exhibit is a high-tension feeder panel equipped with instruments and the control switches for the electrical remote control for the oil switches. There is also a collection of high-tension apparatus, such as horn type lightning arresters, choke coils, &c.

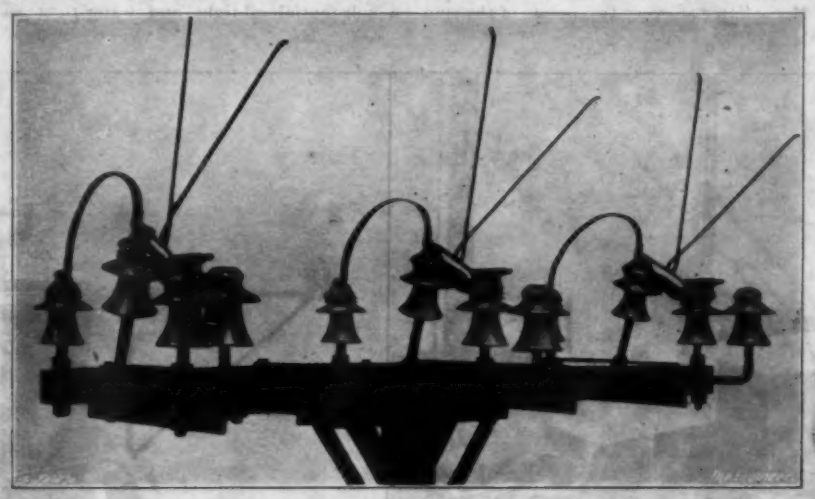


FIG. 30—LINE SECTIONING SWITCH

The North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, has a stand on which the most striking exhibit is a model—Fig. 31—of a quadruple-expansion engine on a scale of 1in. to 1ft. It represents an engine with cylinders 25½in., 36in., 52½in. and 76in. in diameter by 54in. stroke, capable of developing 4400 indicated horse-power when running at 80 revolutions per minute and supplied with steam at 220 lb. per square inch. The model includes a Michel thrust block, which is partly cut away to show the interior, while the stern tube is also cut open. It is complete to the extent that it could be worked by steam, but is driven by a small electric motor. The reversing gear is also operated electrically, so that the engine can be shown running in either direction. On this stand there are also some models of marine return-tube boilers, together with samples of the special combustion chamber wrapper plate used by the makers, which is thickened up at the bottom to give extra strength and dispense with joints at this part. There are several parts of the North-Eastern Werkspoor Diesel engine and a contro pillar for marine Diesel engines. This control device is an interlocking arrangement for preventing the engine being rotated in the wrong direction while manœuvring in or out of port. It is controlled by the telegraph reply lever and it is only possible to move the reversing engine into ahead or astern direction according to the position of lever, the control existing over the whole range of speeds from very slow to full speed.

The latest wireless instruments used on ships are shown by the Marconi International Marine Company, Limited. The object of the marine direction finder, as exhibited, is to enable ships to take bearings of any coast station or other ship which may be using its wireless transmitter. Under ordinary circumstances the working range of the instrument shown is about 100 miles. Accurate bearings can, however, often be obtained at twice or even three times this distance, but at such long distances they are not, as a rule, of very much use for navigation purposes. Under normal conditions, and making allowance for every source of error, bearings obtained by means of this instrument are accurate within 2 deg. Experienced operators, can, however, reduce this error to one-half. Recent reports show that over 90 per cent. of the bearings which have been recorded are within 2 deg. of accuracy. The marine direction finder works in conjunction with a special aerial system, which consists of two loops

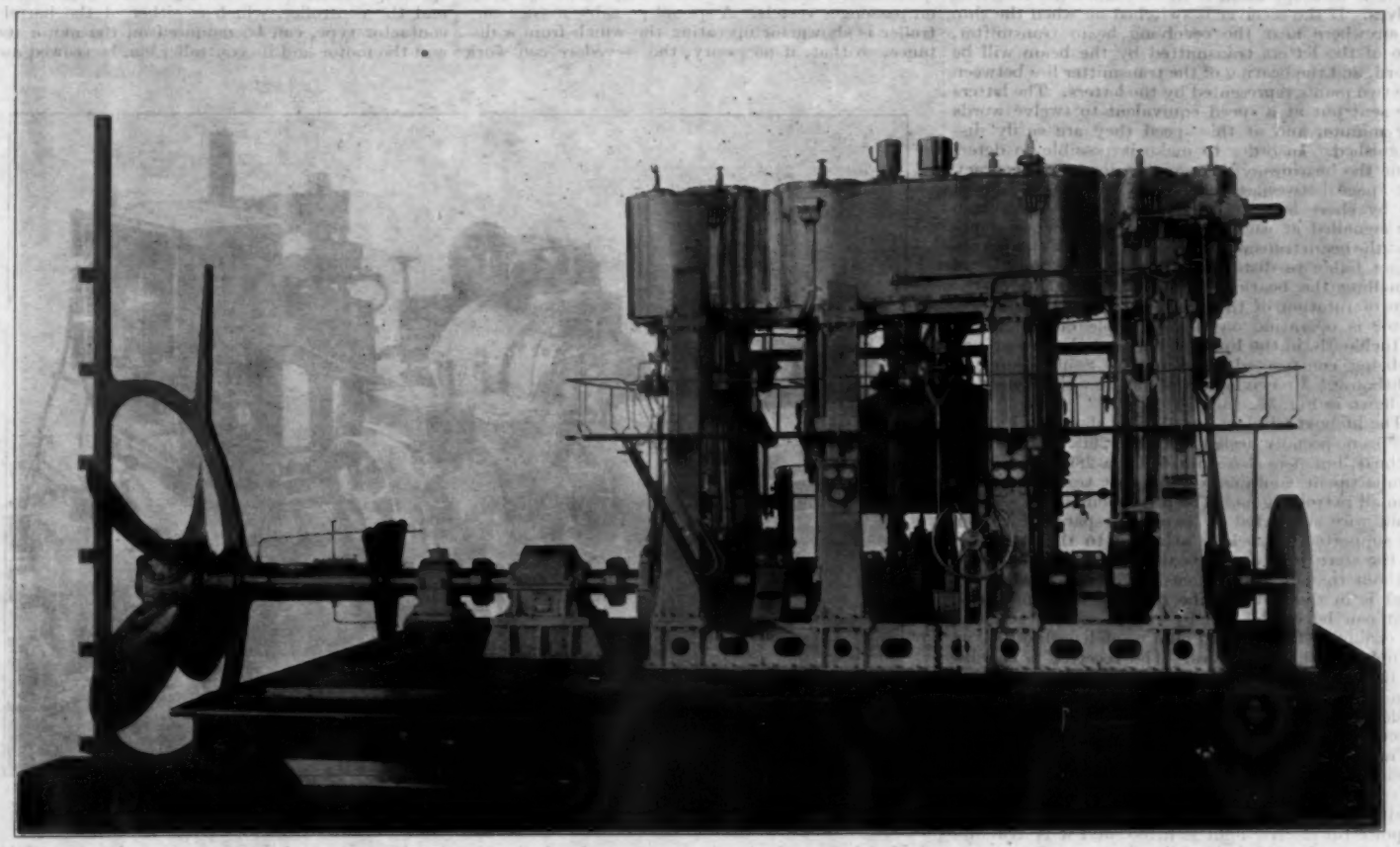


FIG. 31—SCALE MODEL OF QUADRUPLE EXPANSION MARINE ENGINE

of wire at right angles to one another, the area of the loops being between 200 and 250 square feet.

The instrument shown in Fig. 32 is for receiving a rotating wireless beam. The transmitter with which this receiver is associated is installed on land and it projects a wireless signal up to a distance of about 10 miles in a narrow beam, the arc covered being about 20 deg. at full strength, and with a 10 deg. fringe of about half-strength on each side. The projector is slowly rotated, and it sends a prearranged Morse letter at every two points of the compass. The transmission of the signal is made on the extremely short wave-length of 6 m., and the signals sent in this way are entirely free from all kinds of interference. For such short waves a special receiver is necessary. It is entirely independent of the ship's ordinary wireless installation, and it does not require a skilled telegraphist to operate it. The instrument is permanently tuned, and all that is necessary to bring it into operation is to switch on the receiving valves. If the receiver is switched on when the ship is anywhere near the revolving beam transmitter, two of the letters transmitted by the beam will be heard, and the bearing of the transmitter lies between the two points represented by the letters. The letters are sent out at a speed equivalent to twelve words per minute, and at this speed they are easily distinguished. In order to make it possible to determine the bearings with a greater degree of accuracy the space between these "long" letters is divided up by short letters such as "I" or "T," which are signalled at each half-point. Experience shows that the beam transmitted by a projector of this nature is not liable to distortion, and that the method of signalling the bearing is quite independent of the rate of rotation of the projector. A complete projector is operating on this principle on the island of Inchkeith, in the Firth of Forth, and a second one is being constructed close to the South Foreland lighthouse. A receiving aerial for use with the system is shown in Fig. 33.

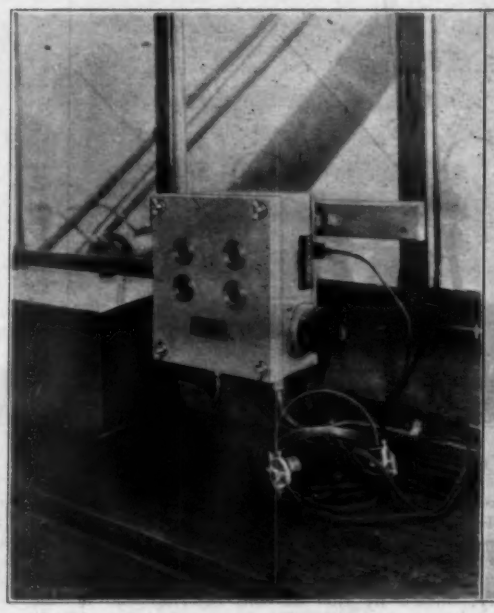


FIG. 32—WIRELESS BEAM RECEIVER

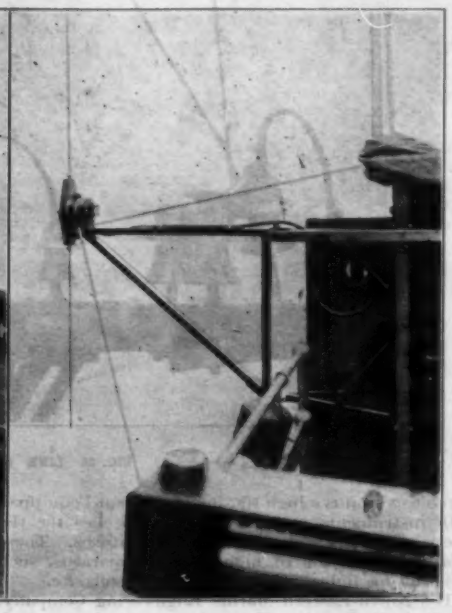


FIG. 33—AERIAL FOR BEAM RECEPTION

The lifeboat wireless installation, shown in Fig. 35, has been specially designed for the 26ft. class A open lifeboat, but it is also suitable for a 28ft. boat. The compartment contains a ¼-kilowatt transmitter and a small petrol engine. The aerial consists of a single stout wire supported by two light spars, which can be supported in sockets attached to the stem and to the stern post of the boat. The spars will stand without rigging, and can easily be erected when the boat is in the water. The range of communication that can be established by means of this set with an ordinary ship working on a wave-length of 600 m. is not less than 50 miles. The receiver is capable of finding the direction of the transmitter, so that if a boat succeeds in getting into touch with a ship which is out of sight, the boat is able to guide the rescuing ship towards her, even if the rescuing ship is not fitted with the direction-finding apparatus. Owing to the difficulties of navigating an open boat at sea, great importance is attached to this direction-finding receiver. On top of the wireless compartment a powerful electric light is fitted, and it is available during the short periods whilst the engine is running. This enables other boats of the same ship to keep in company with the wireless boat at night, and forms a leading mark for the rescuing ship. It is estimated that if it is desired to transmit for ten minutes in the course of every hour, a gallon of petrol will serve for about ninety of these transmissions. The use of accumulators has been avoided, the filaments of the valves being heated by dry batteries. Another of the company's exhibits is a duplex telephone set designed for the purpose of enabling ships which are a short distance from the land to get into touch with offices, the distance which can be covered over sea being about 50 miles.

Among the exhibits of Laurence Scott and Co., Limited, is a self-contained 3-ton worm-geared electric cargo winch constructed in accordance with the Scott patents. The winch is shown in operation and it is lifting loads up to 3 tons. The speeds at all loads are high and fully equal to those of steam winches. The worm gearing runs in oil contained in a substantial oil-tight and water-tight case. The whole equipment, including the foot brake and control gear, is completely enclosed and is specially designed for use at sea and under tropical conditions. All the contactor gear is self-contained with the winch, which is absolutely fool-proof. Hardened and ground steel and phosphor bronze are used in the construction of the worm gearing, which is said to have a very high efficiency at all loads. In operation the winch is quite silent, and it is therefore very suitable for use on passenger vessels. A special portable master controller is shown for operating the winch from a distance, so that, if necessary, the stevedore can work the hatch from the hatch opening or the ship's side. The Laurence Scott well-known "all-electric" steering gear is also shown in operation. The electric bridge control system that is adopted in connection with this method of steering is very simple and reliable. It is worked on the Wheatstone bridge principle, the electrical equipment being composed of a motor generator, and the terminal voltage of this machine is varied by movements of the bridge controller. The main motor drives the Wilson and Pirrie gear, which is also shown, this motor being operated by a simple and reliable contactor controller. An illustration of the Scott electrical steering gear equipment on the test bed is given in Fig. 34.

Other exhibits on this stand consist of electric motors and controllers combined and suitable for driving engine-room auxiliaries. The motors are specially designed for running in hot engine-rooms, and the controller, which is either of the barrel or contactor type, can be mounted on the motor itself and the motor and its controller can be stowed away in odd corners in the engine-room. Another exhibit is an electrical equipment for driving large ships' windlasses. The equipment is composed of a large motor fitted with a magnetic brake of the disc type and a slipping clutch, the control gear being of the contactor type and arranged so that a continual strain is kept on the anchor chain at all loads. There are also large and small ships' generators, automatic starters and regulators, with remote control gear, barrel type starters for engine-room auxiliary machinery, shunt regulators, &c.

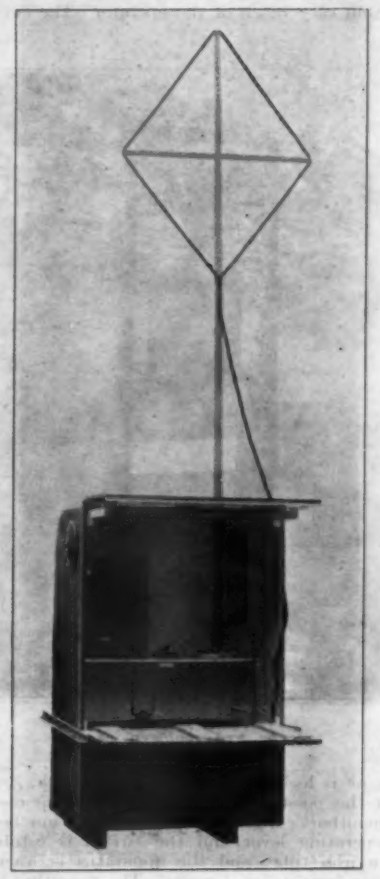


FIG. 35—WIRELESS EQUIPMENT FOR LIFEBOAT

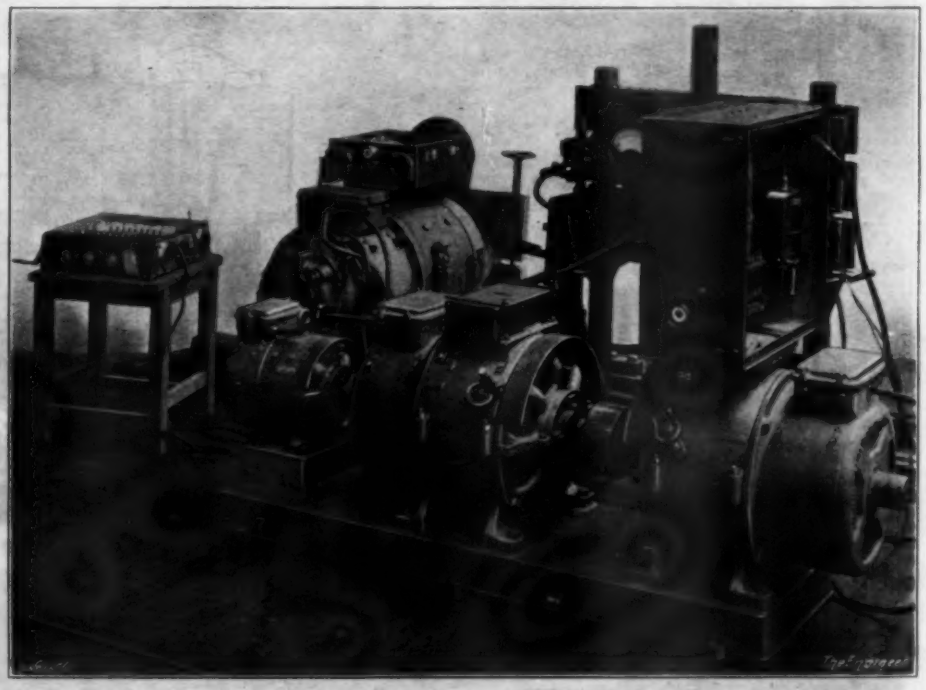


FIG. 34—ELECTRICAL STEERING GEAR

Mechanical Stokers on Marine Water-tube Boilers.*

By W. J. MULLER.

IT may be strange, in these days of liquid fuel burning steamships, to hear about experiments which have been carried out to investigate the possibilities of mechanical coal firing on board of steamships. There is little doubt that liquid fuel has many advantages over ordinary bunker coal, but also one principal drawback, the price. The latter depends more or less on the quantity of crude oil which is found in different parts of the world, and it is certainly no secret that the quantity of petroleum residue available for burning purposes is still somewhat limited. It is also no secret that several shipping companies, which started a few years ago to use oil fuel, have recently converted a number of ships again to coal burning. After this conversion difficulties were encountered in some cases, owing to the labour necessary for hand firing, and for this reason attention has been drawn once more to the problem of mechanical stoking.

It is generally known that this problem is not at all a new one, and during the last twenty-five years more than one shipping company has tried the application of mechanical stokers on Scotch boilers. It is also known that these experiments have never proved to be a complete success, so that at this date the words of Mr. Arthur J. Maginnis,† in his paper concerning "The Advance of Marine Engineering in the Early Twentieth Century," delivered before the Institution of Mechanical Engineers at Liverpool on July 28th, 1909, may be regarded as being still correct. It must be remembered, however, that this sentence more especially referred to experiments with mechanical stokers fitted to boilers of the Scotch type.

Since the introduction of water-tube boilers for ordinary mercantile steamships the situation has somewhat changed, and it is only fair to say that the satisfactory results which have recently attended the use of mechanical stokers on steamships in Holland have been obtained with water-tube boilers, as it was possible to apply mechanical stokers of standard design, as used in land boilers. Two cases, in which mechanical stoking has been adopted on board steamships, will be dealt with more particularly in this paper, as the experiments with them were carried out by the author for the Royal Steam Packet Navigation Company (Koninklyke Pakotvaart Maatschappij), of Amsterdam. It may be of interest to know the reasons which have induced this company to investigate the possibilities of mechanical stoking, as applied to steamships, running on regular services in the Dutch East Indies.

Up to 1921 a great number of the K.P.M.'s steamships used petroleum residue as fuel, and it may be mentioned here that this company started burning liquid fuel in marine boilers as early as 1900. It is also probable that nothing would have changed this practice if the price of Borneo liquid fuel, which in the earlier days of oil burning used to be very cheap, had not gradually increased, until soon after the Armistice the price reached such a height that it proved to be cheaper to burn native coal, even though inconvenient and more troublesome through the lack of skilled native firemen, than to burn the ideal, but also most expensive fuel. As the circumstances could not be altered the interest centred on the question of how to burn native coal so as to give the least trouble to the firemen with the best economic results.

Concerning mechanical stoking, the prospects were not bright, having regard to what had been achieved before by other experimenters; but as something had to be done, it was considered to be safest to start with a mechanical stoker in combination with a water-tube boiler of the Babcock and Wilcox type, of which several had been put in the K.P.M.'s ships during the last ten years. The only difficulty was to decide upon the type of mechanical stoker to be tried.

Amongst the many systems of mechanical stoking which exist nowadays, a few appear to be particularly suitable for water-tube boilers of the land type. These systems are :—

A. The chain or travelling grate stoker.
B. The sloping grate stoker.
C. The underfeed stoker.

The types mentioned under A and B have, perhaps, been applied most, as giving the best economic results, whereas the "Underfeed" type of stoker was at one time favourite for its simplicity and easy operation.

For marine stokers the first requirement is to be reliable, the second to be economic. This means that it should be possible, first of all, to work a marine stoker arrangement under any circumstances, even if the mechanical part goes wrong. In this last case the boiler must be free to be fired by hand.

As the stokers mentioned under A and B both are of a type which cannot be fired by hand, the whole front being occupied by the feeding arrangement—hoppers and feeders or chain grate—there remained only the stoker of type C which can be fired by hand through ordinary fire-doors.

The advantages of mechanical stoking over hand stoking are too well known to be necessary to discuss in detail. One of the principal economic advantages of the leading designs is that the fuel, if of a volatile nature, is coked before combustion, thus permitting the gaseous products which escape from the coal to be burned separately from the coke which remains on the fire-bars; this is a very important item, as the two components of the original fuel require different conditions for perfect combustion.

After much consideration the K.P.M. decided to install a mechanical stoker of the "Underfeed" type into the main water-tube boiler—Babcock and Wilcox system—of two small cargo vessels, the Bintoehan and Parigi, of 1200 and 1500 tons deadweight capacity respectively. Both stokers have been supplied by the Underfeed Stoker Company, of London; the first one, placed on board the Bintoehan, being of the original standard design made by this firm; the second one, on the Parigi, being somewhat modified after experience obtained with the first stoker.

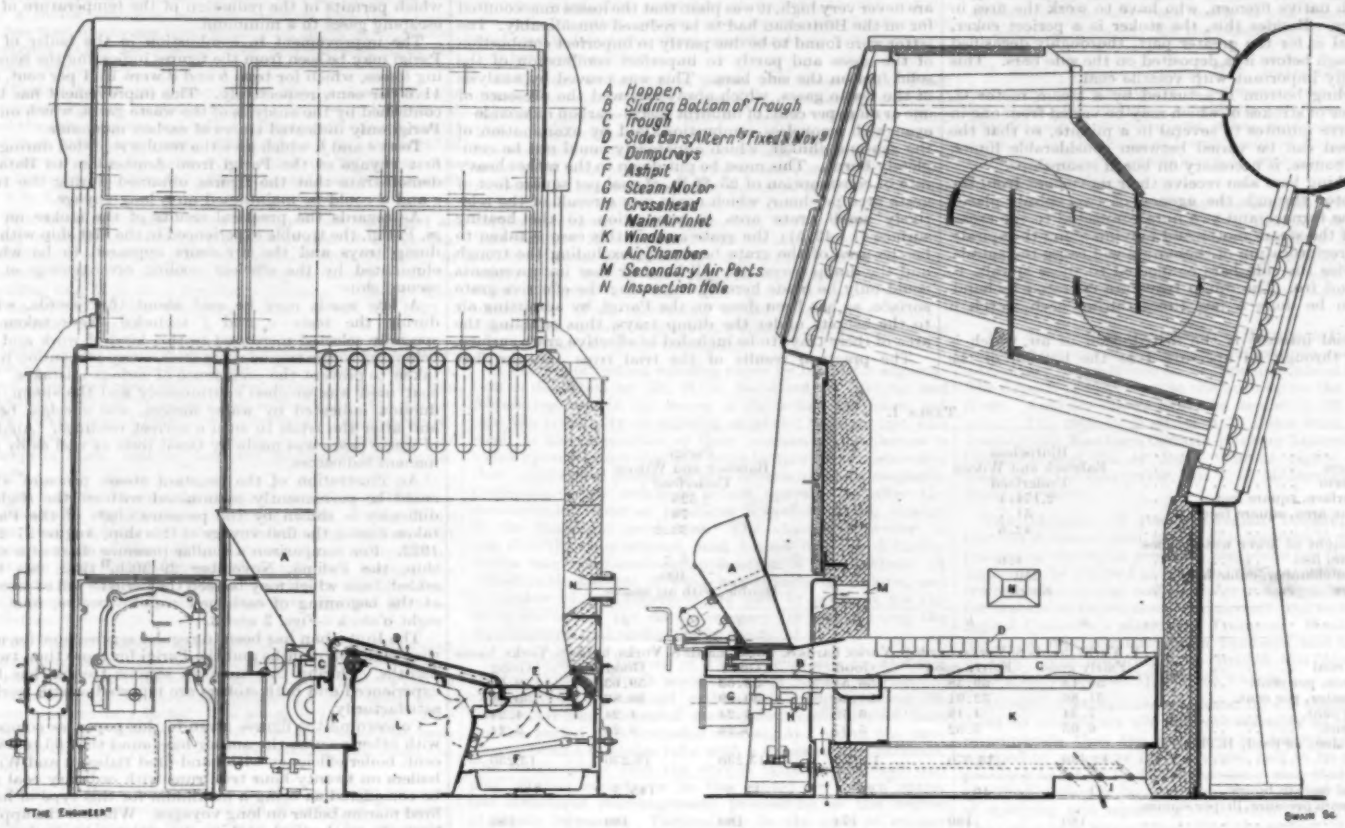
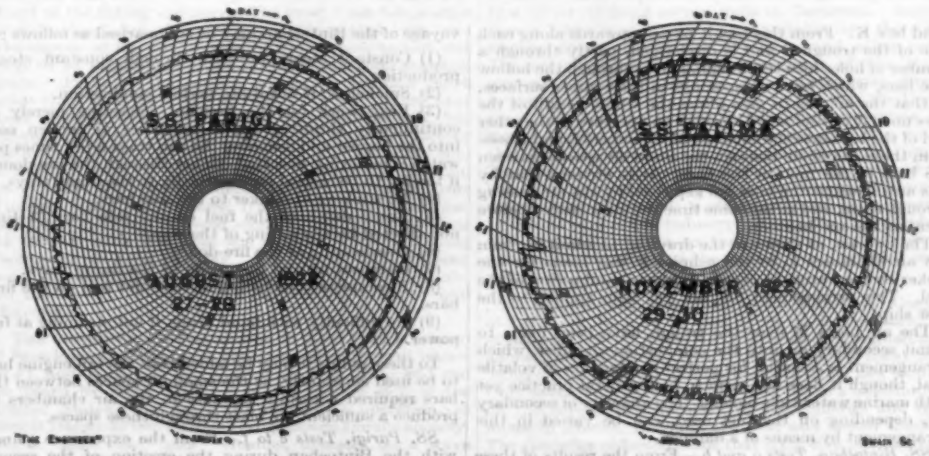


FIG. 1—UNDERFEED MECHANICAL STOKER ON THE DUTCH STEAMER PARIGI

The table on page 280 gives some of the practical results and the tests made during the trials with both ships. The general arrangement of the stokers may be seen from the drawing—Fig. 1—which represents the arrangement as made for the Parigi. The stoker on the Bintoehan, which was described in THE ENGINEER of January 12th, 1923, follows the original design, with the exception of the dump trays, which for this ship were made single and without air spaces, no provision being made for the admission of any forced draught air supply to the ashpits. Also the fire-doors on the Bintoehan did not have the cooling device used in the stoker for the Parigi. As regards the design of the boiler on the Parigi, the average height of the water tubes over the grate has been increased by 1ft. 8in., as compared with the height of the boiler in the Bintoehan, thus increasing the cubic capacity of the combustion chamber, for reasons which will be explained hereafter. The position of the stoker front is not the same for both ships, as this front has been placed under the steam drum on the Bintoehan and in the rear wall of the boiler on the Parigi. The fuel used during the trials and also during the first voyage of both ships was South Yorkshire coal, which has much in common with the highly volatile native coals found in the East Indies, only being of better quality.



FIGS. 2 AND 3—STEAM PRESSURE RECORDS WITH AND WITHOUT MECHANICAL STOKER

The stoker arrangement consists of a hopper A which is filled continuously by hand labour with coal, of which

* Institution of Naval Architects, 1923.

† "A detail of considerable importance to the boiler-room is that of the adoption of mechanical stoking of some description. This, like other subjects, has been the cause of numerous experiments and patents, but so far it cannot be said to be so satisfactorily solved as to ensure universal adoption, although the Henderson system has been largely used."

the bigger pieces have to be broken into smaller lumps before depositing into the hopper. From the hopper the coal is conveyed under the fire by means of a reciprocating sliding bottom B which runs the full length of the trough C. As the coal rises from the trough it is distributed on the side bars D and carried to the sides of the furnace, until it is deposited at last on the dump trays E. This is performed by the action of the moving side bars, which are made to rock or move alternately in a direction at right angles to the trough. The dump trays are operated by levers placed on the outside of the furnace, thus enabling the ash and clinker to be automatically and periodically discharged into the ashpit F underneath the dump trays.

By means of these arrangements the stoker is not only self-feeding, but also self-cleaning, which is of great importance with native firemen, who have to work the fires in the tropics. Besides this, the stoker is a perfect coker, as the coal is, for the greater part, thoroughly degasified in the trough before it is deposited on the side bars. This is especially important with volatile coal.

The sliding bottom is actuated by a steam motor G, the number of strokes of which may be varied from one in two or three minutes to several in a minute, so that the rate of feed can be varied between considerable limits, which, of course, is necessary on board steamships.

The rocking bars also receive their movement from the steam motor through the agency of two spirals placed outside the furnace and two nuts connected to the crosshead H of the steam motor and moving along the spirals. Thus the reciprocation of these nuts will cause the spirals, and likewise the side bars connected to these spirals, to rock to and fro. The dump trays are operated by hand, which can be done a few times during each watch if necessary.

Of special interest is the distribution of air, which is admitted through an aperture I at the bottom of the wind box K. From this box it passes upwards along each side of the trough C and is discharged, partly through a number of holes into the trough, partly through the hollow side bars, which have no openings in their upper surfaces, so that the air has to pass along the whole length of the bars until it is discharged through an aperture at the other end of the bars into the enclosed air chambers L and passes from these chambers through the small air spaces between the bars to the fuel on the bars. It is obvious that by this arrangement the bars are kept cool by the air passing through them, and at the same time the air is heated before it enters the air chambers.

The by-pass, as shown in the drawing, to admit air from the air chambers L to the ashpits F was made for the stoker on the Parigi, to ensure complete combustion of the fuel. This arrangement has not yet been applied to the first ship.

The air ports M over the trough have been made to admit secondary air into the combustion chamber, which arrangement is essential for perfect combustion of volatile coal, though it does not seem to be a general practice yet with marine water-tube boilers. The quantity of secondary air, depending on the fuel used, can be varied in this arrangement by means of a damper.

SS. Bintoehan, Tests a and b.—From the results of these tests, as given in Table I., it will be seen that at a rate of about 5 lb. per square foot of heating surface per hour of steam production the boiler efficiency is approximately 65 per cent., which is certainly not a striking figure. As is shown in Table I., the most important losses have been the thermal losses in the escaping gases—funnel losses—due to the heat which was still left in these gases after having passed the heating surface of the boiler. These losses amount to about 20 per cent., whereas the remaining losses, being the sum of the thermal losses by radiation together with the ash and the losses unaccounted for, represent about 15 per cent. of the original calorific value of the fuel.

To reduce the funnel losses, which as a matter of fact never can be entirely avoided, the surplus of combustion air and also the temperature of the escaping gases should be kept as low as possible. The high temperatures noted during tests *a* and *b*, however, should not be considered in connection with the stoker only, as similar temperatures happen to exist in hand-fired Babcock and Wilcox boilers of the same construction. Investigations on several boilers of the same design have shown the author that improvements as regards this matter can be made only by the adoption of a variable secondary air jet of large capacity delivering into the combustion chamber and by increasing the cubic capacity of this chamber.

Concerning the remaining losses, if the insulation has been properly made, as on the Bintoehan, the loss through radiation should not exceed 5 per cent., which leaves 10 per cent. for the losses unaccounted for and the thermal losses in the ash and clinker. As these thermal losses are never very high, it was plain that the losses unaccounted for on the Bintoehan had to be reduced considerably. The latter were found to be due partly to imperfect combustion of the gases and partly to imperfect combustion of the solid fuel on the side bars. This was proved by analysis of the waste gases, which always showed the presence of one or more per cent. of unburnt gases—carbon monoxide—even with smokeless combustion, and by examination of the ash and clinker, which apparently could not be completely burnt. This must be put down to the rather heavy rate of consumption of 25–26 lb. of coal per square foot of grate area per hour, which again was a result of the relatively small grate area in proportion to the heating surface (1 : 42.5); the grate area in this case is taken to be the area of the grate bars only, excluding the trough and the dump trays. It will be clear that improvements could only be made here by increasing the effective grate surface, as has been done on the Parigi, by admitting air to the ashpits under the dump trays, thus enabling the area of these trays to be included as effective grate surface.

The practical results of the trial trips and the first voyage of the Bintoehan may be summarised as follows:—

(1) Constant steam pressure through constant steam production.
(2) Smokeless, if not quite perfect combustion.
(3) Easy work for the firemen, consisting merely in continuously throwing small quantities of broken coal into the hopper and dumping the ash trays a few times per watch; removing eventual clinker through the fire-doors, if too big to be carried automatically to the dump trays.
(4) No sticking of clinker to the side bars.
(5) Equal depth of the fuel on the side bars (3–4in.) not affected by the rolling of the ship.
(6) Overheating of the fire-doors.
(7) Overheating and distortion of the dump trays.
(8) Incomplete combustion of the solid fuel on the fire-bars.
(9) No difficulty with hand firing, if not steaming at full power.

To these points it may be added that the fan engine had to be used constantly, as the small air spaces between the bars required a certain pressure in the air chambers to produce a sufficient air blast through these spaces.

SS. Parigi, Tests c to f.—From the experience gained with the Bintoehan during the erection of the second stoker a few alterations were made to the arrangement for the Parigi, which have been already mentioned and which are to be found in Fig. 1. From the results, as given in Table I., it may be seen that under almost equal circumstances, as compared with the trials with the first ship, the boiler efficiency of the Parigi has been considerably improved. A comparison of the figures of tests *b* and *d* shows that for a steam production of respectively 4.95 lb. to 5 lb. of steam per square foot of heating surface per hour the coal fired per square foot of grate area per hour was 24.7 lb. for the Bintoehan, against 18.2 lb. for the Parigi, this reduction being largely due to the increase of the active grate surface of the latter, by arranging the dump trays as secondary grates. By this arrangement it has been possible to burn the solid fuel on the side bars almost perfectly, thus leaving practically no fuel to be lost with the ash and clinker. Another improvement is shown by the average temperature of the escape gases on the Parigi, as compared with the Bintoehan; *e.g.*, in tests *b* and *d* these temperatures were 340 deg. and 290 deg. Cent. respectively, which means a decrease of 50 deg. Cent. These temperatures, together with the average CO_2 percentages in the waste gases, account for the thermal funnel losses, which during tests *b* and *d* were 20.1 per cent. and 15.4 per cent. respectively. This improvement must have been due to the increase of the combustion chamber cubic capacity, which affects the combustion of the gases in such a way that practically no combustion takes place outside the combustion chamber, and thus no heat is generated by the gases after they have entered the rows of water tubes, a condition which permits of the reduction of the temperature of the escaping gases to a minimum.

The improvement in combustion in the boiler of the Parigi may be seen from the figures indicating the remaining losses, which for tests *b* and *d* were 15.1 per cent. and 11.6 per cent. respectively. This improvement has been confirmed by the analysis of the waste gases, which on the Parigi only indicated traces of carbon monoxide.

Tests *e* and *f*, which give the results recorded during the first voyage of the Parigi from Amsterdam to Batavia, demonstrate that the figures obtained during the trials *c* and *d* could be maintained on a long voyage.

As regards the practical results of the stoker on the ss. Parigi, the trouble experienced in the first ship with the dump trays and the fire-doors appeared to be wholly eliminated by the efficient cooling arrangement of the second ship.

A few words may be said about the records, which during the tests—*e* and *f* included—were taken by specially selected men used to this kind of work and not belonging to the engine-room staff, every precaution being taken to prevent the occurrence of serious mistakes. The coal used was weighed continuously and the steam production indicated by water meters, was checked before and after the trials to ensure correct readings. Analysis of waste gases was made by Orsat tests as well as by permanent indicators.

An illustration of the constant steam pressure which could be permanently maintained without the slightest difficulty is shown by the pressure chart of the Parigi, taken during the first voyage of this ship, August 27–28th, 1922. For comparison a similar pressure chart of a sister ship, the Palima, November 29–30th, 1922, has been added, from which may be seen the periodic fall of pressure at the beginning of each new watch—twelve, four, and eight o'clock—Figs. 2 and 3.

The Bintoehan has been in regular service now for more than eighteen months and the Parigi for more than twelve months. During this time no serious trouble has been experienced and both stokers are reported as still working satisfactorily.

Concerning the figures given in this paper, as compared with other results, the author has found that 65 to 68 per cent. boiler efficiency with hand-fired Babcock and Wilcox boilers on twenty-hour trial runs with ordinary coal may be considered as being a maximum for this type of hand-fired marine boiler on long voyages. Whether the application of mechanical stoking to water-tube boilers can effect any saving as a whole will depend on the circumstances. Certainly the mechanical stoker has one outstanding advantage, viz., that it makes the shipowner almost independent of firemen. And this is perhaps the most important item, because, if the results have to depend on the behaviour of the *personnel*, it may in some cases be more economic to eliminate the human element by having a mechanical device doing the work and doing it constantly.

Table I.

Steamship	Bintoehan			Parigi		
Boiler system	Babcock and Wilcox			Babcock and Wilcox		
Stoker system	Underfeed			Underfeed		
Heating surface, square feet	2,174.4			2,325		
Actual grate area, square feet	51.7			70		
H.S./G.A.	42.5			33.2		
Average height of lower water tubes over grate, feet	4.0			5.7		
Combustion chamber, cubic feet	240			400		
Dump trays	Single			Double, with air spaces		
Test	*a*	*b*	*c*	*d*	*e*	*f*
Coal	S. Yorks. hards	S. Yorks. hards	S. Yorks. hards	S. Yorks. hards	S. Yorks. hards	S. Yorks. hards
Quality of coal	Fairly good	Fairly good	Good	Good	Good	Good
Fixed carbon, per cent.	54.15	59.38	56.54	59.63	59.63	59.63
Volatile matter, per cent.	31.86	32.91	31.80	30.89	30.89	30.89
Water, per cent.	7.34	4.19	6.59	4.24	4.24	4.24
Ash, per cent.	6.65	3.52	5.07	5.24	5.24	5.24
Calorific value, as fired, B.Th.U. per pound	12,430	13,570	12,620	13,230	13,230	13,230
Duration of test, in hours	11	16	22	17.5	145.5	190
Average steam pressure, lb. per square inch	180	180	174	180	180	180
Steam evaporated, total in lb.	115,390	172,480	224,620	204,050	1,541,100	1,835,460
Steam per square foot of H.S. per hour, lb.	4.82	4.95	4.4	5.0	4.56	4.15
Coal fired, total in lb.	14,850	20,240	24,930	22,440	164,120	193,950
Coal per square foot of G.A. per hour, lb.	26.2	24.7	16.2	18.2	16.1	14.6
Steam per lb. of coal (from and at 100 deg. Cent.), lb.	8.45	9.28	10.1	10.13	10.4	10.4
Ash removed during test, lb.	1,122	1,474	Not measured	Not measured	14,022	17,490
Average CO_2 in funnel waste gases, per cent.	11.6	11	11.4	12.2	11.8	12.5
Temperature of funnel waste gases in degrees Cent.	370	340	270	290	295	283
Average air pressure at fan, inches	2	2	1	7/8	1	1
Boiler efficiency, per cent.	64.5	64.8	75.5	73	75	75.7
Thermal loss in waste gases, per cent.	20.7	20.1	15.5	15.4	16.2	14.7
Unaccounted for, radiation, ash, per cent.	14.8	15.1	9.0	11.6	8.8	9.6

MINING AND METALLURGICAL CONGRESS.

The following institutions are co-operating as conveners of the Empire Mining and Metallurgical Congress, which will be held at the British Empire Exhibition in London during the first week in June, 1924:—The Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Iron and Steel Institute, and the Institute of Metals representing the scientific and technical interests of the mineral and metal industries, with the Mining Association of Great Britain and the National Federation of Iron and Steel Manufacturers representing the colliery proprietors and iron and steel manufacturers respectively of the British Isles.

Viscount Long of Wraxall (late Secretary of State for the Colonies) has accepted the invitation of the Institution of Mining and Metallurgy to deliver the "Sir Julius Wernher Memorial Lecture" at the opening session of the Congress, and he will take as his subject "Mineral Resources and their relation to the Prosperity and Development of the Empire." The "May Lecture" of the Institute of Metals, to be delivered by Dr. F. W. Aston, F.R.S., will also form part of the programme of the Congress. Dr. Aston's subject will be "Atoms and Isotopes."

A railway accident, of which Monday last, the 10th instant, was the forty-ninth anniversary, that should be remembered was that which occurred between Norwich, Thorpe and Brundall, when an express from London came into head-on collision with the mail from Yarmouth on a single line. It was one of those accidents, which still occur, which result from a too ready assumption that something or other would not be done. The inspector had told the telegraph clerk at Thorpe Station to instruct Brundall to send on the mail. On leaving the office the inspector saw the express running into the station. That would allow it to have the precedence, but as he had not signed the telegraph form the inspector did not return to the office to cancel the instructions; he assumed they would not be sent. But the message had gone, and the two trains met. Twenty-one passengers and all four enginemen were killed, and it may be remarked in this connection that doctors were sent for and medical relief sought before news was received of the collision. The line was worked by crossing orders and without the train staff or the block system.

Railway Matters.

A MESSAGE from Valparaiso states that a project is to be submitted to Congress for the expenditure of 80,000,000 dollars on the construction of new railways in Chile.

NEW coaling staiths are to be erected by the London and North-Eastern Railway Company at Blyth at a cost of £86,000. The contract has been let to Messrs. Mitchell Brothers, of London.

IT was twenty years on the 4th ult. since the Great Western Railway Company opened its road motor services by a motor omnibus between Helston and the Lizard. It has now ninety-six cars running on thirty-seven routes, covering 40,000 car miles a week and carrying 3,000,000 passengers a year.

DURING the holiday season, the 10.30 a.m. Great Western "Cornish Riviera" express has been divided on Saturdays, and the first part has not called at Plymouth (North-road), but gone on to Devonport. This increased this remarkable non-stop run by 1¼ miles—from 225¾ to 227 miles. On the inaugural run on July 23rd, the distance was covered in 4 h. 3 min.

THE London "Safety First" Council has organised an essay competition among the railwaymen of all grades, including the clerical staff, employed within 20 miles of Charing Cross. The subject is "How Accidents could be Avoided and Why such Accidents Happen." Essays may be based on Colonel Pringle's annual report for 1922—Cmd. 1926, price 6d.

IMPROVEMENTS in the railway accommodation in Ramsgate, so as to combine the "Town" and "Sands" stations, have often been discussed. It is now announced that the Southern Railway Company has submitted to the Ramsgate Town Council plans for a combined station near St. Lawrence. An additional station is to be provided at Dumpton Park, midway between Ramsgate and Broadstairs.

THE "safety" campaign of the Great Western Railway is deservedly well known all over the world. It has lately been amalgamated with the ambulance movement, and it gives much satisfaction to the servants of the company that the chairman, Viscount Churchill, has become the President of the Great Western centre of the St. John Ambulance Association in succession to the late Princess Christian.

THE Vale of Rheidol Railway was part of the Cambrian system, and is therefore now included in the Great Western. It runs from an independent station in Aberystwyth to Devil's Bridge, and there is one stretch of 4 miles on a rising gradient of 1 in 50. The gauge is 1ft. 11½in. Two new 2–6–2 tank engines, built at Swindon, have just been put into use. They take two more coaches than could the Cambrian engines.

OWING to the confusion due to the grouping arrangements, the railway statistics of the Ministry of Transport appear some four or five months late. The estimated traffic receipts of the Great Western Railway Company, as published in the *Great Western Railway Magazine*, afford, however, some clue to the general condition. The passenger receipts for the four weeks ended July 15th last were estimated to have been £1,146,000, as against £1,254,000 for the same four weeks in 1922, and the goods receipts £1,366,000, as compared with £1,493,000. Roughly, these figures represent decreases of 9 per cent., which is more than can be ascribed to the reductions in fares and rates.

THE situation over the season-ticket controversy, referred to in our Journal page last week, has been very much improved by the companies having agreed to negotiate with a committee representing the holders of season-tickets. This step is the result of an inquiry addressed by the Railway Rates Tribunal to the companies asking whether they were treating the representatives of passengers on the same terms as the representatives of traders, and furnishing the former with copies of all documents supplied to the latter in connection with the schedules of proposed standard charges. The companies have replied that if a committee similar to the Traders' Co-ordinating Committee could be formed to represent the interests of the travelling public they would be pleased to negotiate with such committee and supply it with information.

THE report has just been issued by the committee appointed to investigate the training of natives on the Indian railways. It recommends the creation of a comprehensive scheme for railway education based on present institutions. Owing to social and industrial difficulties, coupled with the fact that Indian railway problems are of a different type from those of England, it is not considered advisable to send Indians to England for railway training. The need is emphasised for raising the standard of lower-grade labour, which is at present very poor. As to the possibility of training Indians to replace European subordinates, of which the supply is likely to diminish, the report gives details of the educational requirements, but points out the necessity of eliminating the communal prejudices which are stated to hamper to a considerable extent the efficiency of the Indian supervisory staff.

OTHER appointments in the engineering department of the Southern Railway under Mr. A. W. Szlumper, the chief engineer, in addition to those of Mr. G. Elson as deputy chief engineer, and Mr. W. J. Thorrowgood as superintendent of signals, telegraphs and telephones, already announced, came into operation on the 1st inst. They are:—Mr. J. F. S. Tyler, chief assistant; Mr. F. C. Stainton, new works engineer; Mr. W. A. Messer, assistant for permanent way; Mr. J. Scott, chief architectural assistant; Mr. A. Cunnington, assistant for lighting, heating and water. The district engineers are:—Mr. C. A. G. Linton, London East District, London Bridge; Mr. H. I. Bond, London West District, Clapham Junction; Mr. C. V. Hill, Portsmouth District, Brighton; Mr. H. Robarts, Southern District, East Croydon; Mr. J. Shaw, Eastern District, Ashford; Mr. P. S. J. Bishop, Central District, Eastleigh; and Mr. W. H. Shortt, Western District, Exeter.

Notes and Memoranda.

THE United States Bureau of Mines has been conducting an investigation into the employment of colour test papers for detecting hydrocyanic acid vapour in the air of tanks, apparatus, and in ships and buildings after fumigation. A method was developed whereby the shade of colour produced in tests when compared with a colour chart gives an estimation of the concentration of the gas over a range of 25 to 1000 parts per million parts of air. The investigators' determinations in the laboratory were within 20 per cent. of those found by chemical analysis. It is recommended that unprotected persons should not be allowed to enter atmospheres containing hydrocyanic acid gas unless tests show concentrations not exceeding 100 parts per million.

IT is curious to notice, states the *Motor*, what great differences exist in the capacity for resisting electrical currents possessed by various people. The late Lord Kelvin was practically immune from current which would have sufficed to electrocute any ordinary man, a fact which must have been of great service to one constantly engaged in electrical experiments. On the occasion of the opening of a railway, Kelvin startled his friends by gripping a copper conductor, carrying current at 500 volts, with his bare hands. He explained that his immunity was due to the exceptional dryness of his skin. There was a mechanic engaged on testing aero-engines at a large motor car factory during the war who had the same peculiar immunity. This individual would cheerfully "short" three or four sparking plugs on a running engine by placing his bare arm along the terminals.

A SYSTEM of testing winding ropes by magnetic exploration is described by Mr. R. L. Sandford in *Mining and Metallurgy*, and in the course of the article he points out that the possibility of utilising magnetic tests on iron and steel for the estimation of their mechanical properties is based upon the fact that the same factors which determine their mechanical properties also determine their magnetic properties. Any influence which operates to alter the mechanical properties produces a corresponding change in the magnetic properties. The change, however, is not directly proportional, and herein lies the difficulty in the way of immediate application of the method. A considerable amount of work has already been done, and a number of investigations are now in progress for the accumulation of the data necessary for determining the relationships that undoubtedly exist.

THE *Japanese Journal of Physics* contains an abstract of Mr. Akimasa Ono's account of his X-ray interference examination of strained metals, viz., copper wires (in the drawn and annealed states), low carbon steel bars (in the pulled and annealed states), &c., using the rays issuing from a Coolidge tube with a tungsten anti-cathode. The results show that the crystal lattices of metals display fibrous structures in the pulled or drawn state, the structural rearrangement proceeding as the degree of strain increases. Particularly in the case of copper of which the atoms are known to be arranged in a face-centred cubic lattice, the inclinations of several simple planes in the lattice to the primary ray and the relative intensity of diffracted rays are calculated. It is shown that the group of small crystals considered to be symmetrically arranged in such a manner that the trigonal axis of the lattice stands in the longitudinal direction of wire, gives rise to the pattern obtained in the experiment on wires drawn to a sufficient degree. It is suggested that the changes in the lattice arrangement of crystals afford a natural explanation of the change of properties observed in metals that have been subjected to strain.

WHEN an inquiry was made by Dail Eireann into the condition of the fisheries in Ireland a few years ago, states a contemporary, stress was laid upon the absence of refrigeration facilities for the preservation of the fish. Outside Dublin, there was no ice factory at any of the ports, and this was found to be a great barrier to the development of the fishing industry. The great fresh fish market was England, but there were no refrigerated cars, and the supply of ice was uncertain, while quick transit was said to be rather a question of luck than good management. Probably the general conditions are now much what they were then, but in Dublin, at least, there have been developments. The Dublin Trawling, Ice and Cold Storage Company, Limited, has opened a new ice factory with a capacity of 25 tons of ice per day, the main consideration being, of course, ample supplies for the company's trawlers—ten or a dozen steam trawlers fish from Dublin. Then the National Ice and Cold Storage Company has increased the cold storage capacity of its plant to 100,000 cubic feet, and the output of its ice-making factory to 40 tons per day. The aim of Dail Eireann was, and doubtless is, to have small refrigerating plants, on the Danish model, at the chief fishing ports around the coast.

THE latest broadcasting station in New York is termed "Broadcast Central," and operates under the call letters WJY and WJZ. It was opened on May 15th, and can be heard by radio listeners on the eastern side of the United States. It has "two channel" operation, so that it transmits two different programmes simultaneously. WJY, called the "jazz" channel, operates on a wave length of 405 m., and broadcasts popular music, news, lectures, &c. The WJZ channel operates on a wave length of 455 m. and broadcasts operatic and classical music. Both the studios are on the sixth floor of the Æolian Hall, which is in the centre of New York City. As concerts and recitals are always being given in this hall, arrangements have been made to broadcast them. Special line wires have also been run to the more important theatres and hotels, so that outside performances can be readily transmitted. The antennæ are strung from two 120ft. towers located on the roof at a distance of 175ft. apart, and form two separate four-wire horizontal systems separated by ropes and insulators. The length of the wires forming one system is 45ft., and the length of the other system is 55ft. As the output of a high-quality microphone seldom exceeds a few millivolts, considerable amplification is necessary.

Miscellanea.

THE Tercentenary Jubilee Exhibition at Gothenburg, Sweden, continues to attract large numbers of visitors from all corners of the world, and the Council of the exhibition has, on account of numerous requests, decided to keep the exhibition open until October 15th, instead of September 30th, as originally announced.

LARGE deposits of bauxite are reported to have been discovered in the province of Permak as a result of explorations carried out under the leading of M. Tumanoff, and 160 tons are said to have already been produced. An application has now been made to the Supreme Council of National Economy for the allocation of funds to work the deposits.

A MESSAGE from Victoria, B.C., states that a contract involving an expenditure of approximately 350,000 dols., for electrical pumping machinery with a capacity of 180,000 gals. a minute, and other equipment, has been awarded by the Federal Department of Public Works for the electrical work in conjunction with the new dry dock at Esquimalt.

A DISCOVERY of silver has been made 47 miles from Chillagoe, Queensland, and the Minister of Mines has stated that it will probably prove another Broken Hill. Ten samples, taken 100ft. apart, averaged 52 oz. to 70 oz. of silver to the ton, with 50 per cent. of lead. In a gully between two hills pure galena was found, assaying 116 oz. of silver and 80 per cent. of lead.

THE discovery is announced in Northern Ontario of an immense deposit of gypsum, which extends one mile along a tributary of the Moose River, running inland for 10 miles. The deposit is 40ft. deep at the outcrop on the bank of the river. Analysis shows that the deposit is 99.8 per cent. pure. The deposit is situated 12 miles from the Temiskaming and Northern Ontario Railway extension between Cochrane and James Bay. Patent rights have been granted to the discoverer, Mr. T. J. McDermid, Sault St. Marie, Ontario.

THE Director of the Norwegian Telegraph Services recently returned from a tour of inspection in the northern provinces, where he prepared the plans for the new radio station to be erected at Vardoe. This station will have a transmission radius sufficient for messages to be sent to the station at Ingoe, near Hammerfest, and to the Meteorological Institute's station at Tromsoe. Weather reports are to be sent regularly from Tromsoe, and they will be of very great importance to British and other trawlers fishing in Arctic and White Sea waters.

A SPECIAL committee appointed by the Ontario Government to investigate the iron ore industry of the province recommends that the industry be encouraged and developed by a bounty for ten years, half to be paid by the province and half by the Dominion; also that a properly qualified geologist be permanently assigned to the work of studying and reporting on Ontario iron ore deposits. The committee recommends that the section of the Mining Act prohibiting the export of iron ore should be repealed in order to encourage the entrance of foreign capital for developing this industry.

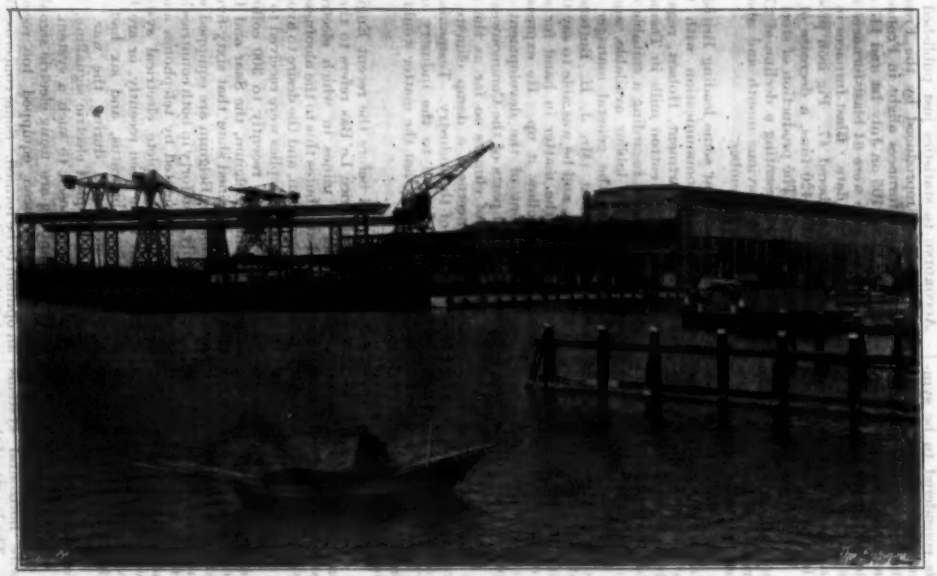
ACCORDING to statistics just published by the Comité des Forges and reproduced by the French papers, the number of blast-furnaces alight in France on August 1st was 107, against 105 on July 1st and 115 on January 1st. In addition, there were 64 blast-furnaces ready for operation on the same date. Blast-furnaces in repair or under construction numbered 47. Pig iron production in July amounted to 430,420 tons, a decrease of 10,593 tons on the June figures. The production of steel in July reached 399,525 tons, representing a decline of 27,870 tons compared with the previous month and about 15,000 tons compared with December.

IT is reported that some leading British cotton manufacturers are in communication with the Tasmanian Hydro-electric Department, Hobart, regarding the question of establishing cotton mills in Tasmania. Information is being sought regarding a suitable site, the cost of electric power, the labour available, and other points. The attention of the general manager of the Hydro-electric Department (Mr. J. H. Butters) was directed to the statement, and he was able to say that the Department had had the matter in hand for some time, and would closely follow it up. He expressed the opinion that in the event of the development of the project, Tasmania, of all parts of the Commonwealth, would have the advantage of climate so far as the manufacture of cotton was concerned, a damp climate being essential to the success of the industry. Tasmania, he considered, was admirably suited to the industry in that respect, and he was hopeful that the matter would proceed on the right lines.

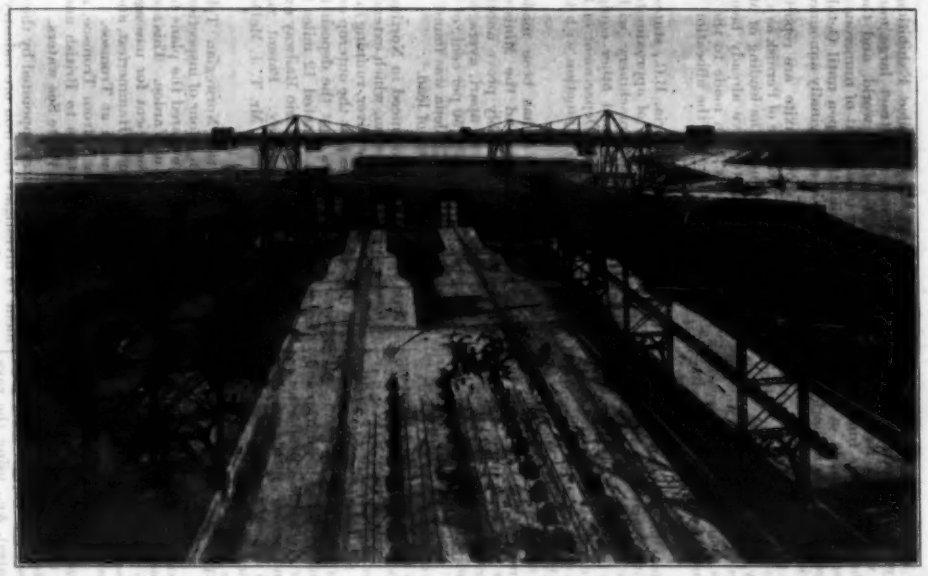
IN a paper read before the recent Engineers' Congress at Liège, M. Maurice Le Bas refers to the comparatively small number of mines in which electric signalling is adopted, and attributes this to the aloofness of many mine-owners, conservatism, and the desire to avoid new troubles. Only seventy-eight replies were received to a questionnaire on the subject sent recently to 300 collieries and metal mines in France, Belgium, the Saar and Dutch Limburg. The statistics obtained show that sixty-five pits in France and twenty-one in Belgium are equipped with mechanical signalling only, and forty in both countries have mechanical signalling supplemented by telephones and electric bells. Seventeen have complete electrical systems in normal service, eight have been recently, or are being, equipped with electrical apparatus, and six had their electrical equipment destroyed during the war. Twelve mines have not yet adopted electric signalling, and the owners of seven are opposed to such a system. Four collieries in Dutch Limburg are using electric signals with success, and two have been equipped too recently to enable an opinion to be formed. Some concerns, though generally satisfied with their electrical systems, recommend greater simplification and endeavours to secure increased robustness of apparatus, which it is important should be water-tight. All users agree that electrical signalling is quick and safe.

THE NEW SHIPYARD OF THE NETHERLAND SHIPBUILDING COMPANY AT AMSTERDAM

(For description see page 275)



THE YARD SEEN FROM THE NORTH SEA CANAL



VIEW SHOWING UPPER PART OF SLIPWAYS

LAYING DOWN PLATES FOR SECTION OF FLOATING DRY DOCK

COMPLETED DOCK SECTION READY FOR LAUNCHING

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND Co., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386-388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTNA AND CO., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 12s. 9d.
Yearly	£3 2s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. .. £3 3s. 0d. ,,

. READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

. The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

Postal Address, 35, Norfolk-street, Strand, W.C. 2.
Telegr. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

. *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

. *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

. *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, September 14th, 1923.	PAGE
A SEVEN-DAY JOURNAL	269
SCIENCE AND INDUSTRY IN AMERICA.—No. I.	270
THE HAMBURG-AMERICAN LINER ALBERT BALLIN.—No. I. (Illus.)	271
INSTITUTION OF NAVAL ARCHITECTS.—No. II.	272
THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—No. III. (Illus.)	276
MECHANICAL STOKERS ON MARINE WATER-TUBE BOILERS. (Illus.)	279
MINING AND METALLURGICAL CONGRESS	280
RAILWAY MATTERS	281
NOTES AND MEMORANDA	281
MISCELLANEA	281
LEADING ARTICLES—	
The Geared Drive	283
Payment by Results	283
ELECTRICAL STRUCTURE OF MATTER	284
OBITUARY—	
E. R. Walker	285
ELECTRICITY IN MINES.—No. VIII. (Illus.)	286
THE INSTITUTE OF METALS.—No. I.	287
SIXTY YEARS AGO	289
INTERNAL COMBUSTION ENGINES EXHAUSTING INTO LOW-PRESSURE TURBINES. (Illus.)	290
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	291
Lancashire	291
Sheffield	292
North of England	292
Scotland	293
Wales and Adjoining Counties	293
MANCHESTER UNIVERSITY DEPARTMENT OF METALLURGY	293
LAUNCHES AND TRIAL TRIPS	293
CURRENT PRICES FOR METALS AND FUELS	294
FRENCH ENGINEERING NOTES	295
BRITISH PATENT SPECIFICATIONS. (Illus.)	295
FORTHCOMING ENGAGEMENTS	296
PARAGRAPH—	
The Institution of Automobile Engineers	291

THE ENGINEER.

SEPTEMBER 14, 1923.

The Geared Drive.

THERE is a variety of interesting matter in the short paper which Professor Dresden read at the recent meeting of the Institution of Naval Architects, but it is not surprising that the discussion turned almost solely upon the reducing gear of turbine-driven ships. Wherever marine engineers and naval architects are gathered together, this subject arises sooner or later. There may be some bold enough to deny that there is any cause for anxiety in the present conditions, they may tell us, as Mr. R. J. Walker did in Holland, that there are five hundred merchant ships, with a total of two and a-half million horse-power, fitted with turbines and reducing gear; they may assert that the rigid double reduction gear is not nearly as bad as it is painted; and that the number of breakdowns is inconsiderable. All this they may do, but the fact remains that anxiety does exist amongst marine superintendents and shipowners, and that there is still not that complete confidence in the turbine and gearing that there is in the reciprocating engine. In some quarters this anxiety is so great that old-fashioned reciprocating engines are ordered despite their lower efficiency, in preference to geared turbines, or, as in the case of the 65,000 horse-power fast cruisers for the Dutch Navy, which are now being constructed, direct-coupled turbines are being employed, so that the uncertainty associated with gearing may be avoided. In these circumstances, it is idle to deny that the matter is serious. Whatever statistics may say, the fact remains that marine engineers are not perfectly happy with the geared drive.

In the early days of turbine gearing, a clear division of practice took place. On the one hand, American engineers, led by George Westinghouse and Colonel Macalpine, decided that a rigid connection between the pinion and wheel shafts would lead to trouble; whilst, on the other, British engineers, with Sir Charles Parsons at their head, contended that if the gear were properly cut, the flexible connection was unnecessary. To the latter opinion British engineers have held ever since, and it is only within the last few months that some sort of doubt as to its wisdom has begun to arise. The view is, we believe, gradually gaining ground that the conditions on shipboard are such that, even with practically perfect gears, a certain amount of flexibility is desirable. For ourselves, we have never been able to understand why geared-turbine builders in this country persisted in the belief that the gear casing was rigid. That they did do so is obvious from their adherence to rigid gears, for it is clear that rigid gearing can only work accurately in a rigid casing. The slightest straining of the casing leads to disalignment of the bearings, disarrangement of the tooth contact, and the creation of unknown stresses. To make a casing that will not distort in some degree under the influence of the working of the ship in a seaway, under changes of temperature and other possible forces, is, we hold, impossible, and despite the success attained with the majority of British-built vessels, we are disposed to agree with the American view, and to support Professor Dresden's opinion that a flexible connection reduces the chances of failure. It is to be regretted that at the meeting in Holland there was not present some engineer, conversant with American practice, who could have given figures to show the immunity or otherwise of the Macalpine floating-frame drive. If it can be shown that that device is not consistently successful, then we must accept the British view that failures of marine turbine reducing gear are caused by bad gear cutting, bad lubrication, bad metal, bad alignment, excessive tooth pressures, or any other of the causes usually assigned. If, however, that gear is consistently successful, other things being equal, then we ought to admit at once that we have made an error in adhering so long to the rigid drive and reform our practice. Indeed, the whole subject is one on which greater flexibility of thought and more daring in experiment is needed. Take, for example, the question of the use of helical gear. Of its merits we are all well aware, but we must equally admit that it has very serious faults, of which the difficulty of accurate production is, perhaps, no longer the first. In that position we are inclined to place the necessity for lateral stability, for considerable stresses may be set up by trifling endways movement of the pinion. Recent improvements in the production of straight gears have shown conclusively that they can be made to run as silently as double helical gears; they are more easily produced with a high degree of accuracy; and small lateral movements are immaterial to them. We should be glad indeed to see an experiment made with a small set of these hardened and ground gears in a ship. Transmissions of 500 horse-power have already been constructed, and we have little or no doubt that double that amount could without great difficulty be provided for.

But there is another aspect of this subject which is rarely mentioned, but which Professor Dresden may have had in mind when he wrote: "There is always the possibility that it [double reduction gearing] will, in its turn, be superseded by the next step in the direction of progress. The author does not want to prophesy——." It must be remembered that the propeller was invented for use with relatively slow-speed reciprocating engines. With the steam turbine it forms an ill-assorted pair. It ought, rightly, to be regarded as a make-shift to enable the advantages of the high-speed turbine to be secured under conditions which are properly those of slow-speed engines. What is required now is not so much improvement of reducing gear as the discovery or invention of a new means of propulsion which is suited to turbine speeds. Speed reduction by gearing, by hydraulic appliances or by electric generators and motors must all be placed in the same category. They are unnecessary with the reciprocating engine; it should be the constant aim of inventors to make them unnecessary with the steam turbine.

Payment by Results.

THE idea of substituting, wherever possible, the payment by results for ordinary time rates of wages has been carried out in practice in one form or another ever since the beginning of history. Piece-work, bonus and premium systems—the modernised and standardised forms of payment by results—have been used in engineering and other industries for many years, and in many instances have justified the faith of those who advocated their adoption as a means of improving efficiency of operation and at the same time of increasing the earnings of the individual workman. But for various reasons trade unions, and indeed some employers, are either lukewarm in their support of the movement or passively, at least, in opposition to it. It needed the experience of the war period, when all other considerations were overridden by the need of high output, to demonstrate to doubters the character of the spur it gave to production by the appeal to individual initiative. Ever since, all those who realised that the task of reducing manufacturing costs must be accomplished by methods which will not depress the earnings of the workman below the level demanded by the cost of living have been studying methods of payment by results, in the hope of bringing about a revival of

British industry. Hence, employers are far more ready to consider systems of payment by results than they were. Unfortunately, the resistance of the trade unions still persists. To a certain extent the employers themselves are responsible or it, for some of them, taking a misguided view, cut rates whenever it was found that the workman by dint of application had increased his earnings beyond a certain point. But that argument, although it is always used by the opposing unions, is, in fact, little more than a cloak to cover the objection that exists amongst workmen to the advance of their fellows. They insist on using "time spent" as the unit of value, and regard greater ability or greater skill as fortuitous gifts of Providence for which those possessing them have no right to receive exceptional rewards. Greater industry they oppose on the double ground that it enriches the employer and tends to displace those workmen who are either incapable of continued effort or do not desire to exercise it. The result is that a feeling of hostility in the minds of a majority of the working forces in industry exists against the regulation of earnings by output.

It is obvious, however, that a stage has been reached when a change must be made in the interests of all concerned. It is a subject for congratulation, therefore, that there is now revealed a tendency among both employers and employed to tackle the problem anew. That cheap selling prices following on low costs of production are not incompatible with high earnings by the men in the shops has been shown by the experience of American manufacturers. In Great Britain there has been too great a tendency to insist that the labourer is entitled to a definite material reward for his day's work, irrespective of the value of the output, and there is no room for doubt that in certain branches of engineering, and notably in the shipbuilding industry, an uneconomic situation has been created where the cost of the product is higher than the market value. There is no escape from this plain fact which has been established by the pressure of hard times. One remedy for this condition of affairs is to make the wages paid to workmen bear a definite relation, not to the artificial cost of living—which is the parrot cry of the time and assists to keep the price of food and other essential commodities at an inflated level—but to the selling price of the product. Mr. Ayde, the well-known shipbuilder, who has recently discussed this question in his works journal, favours the adoption of a sliding scale based on average demand, in the ascertainment of which the returns of Lloyd's Register of Shipping would be accepted, and which in one sense would imply an indirect acceptance of a payment by results scheme. Others prefer a more direct application of that principle, as in the Priestley scheme or the familiar Halsey and Rowan systems. Another scheme is that which was outlined in a note which appeared in our Journal a few weeks ago, and a later manifestation of the new spirit is the attempt which is being made on the initiative of the Admiralty to extend the payment by results system, which has already been tested with a certain measure of success in the Royal dockyards. There is already ample evidence from the investigation made some time ago by a joint committee of the men's and employers' representatives—see THE ENGINEER, October 6th and 13th, 1922—of the very marked improvement in the output of shipyards when piecework is substituted for time rates, and we welcome the signs given by the negotiations which have been opened up of a desire to extend this system to other classes of work to which it can be applied. We hope that these things predict a recourse to saner methods in dealing with questions of wages and working conditions. One must not imagine, however, that the reform movement is going forward without check, or that an effort will not be made, partly from ignorance and partly as the result of suspicions engendered in the minds of the men from past experience, to attach to the acceptance of the payment by results principle conditions which may rob it of some of its advantages. It should be noted, for example, that the draft agreement of 1920 between the unions named and the Engineering and National Employers' Federation, which is now under revision, contains clauses to the effect that day work time rates of wages are to be guaranteed irrespective of earnings, and that recognised overtime, night shift, Sunday and holiday allowances, calculated on day work time rates, are to be paid in addition to earnings under any other system of ascertaining wages which may be approved. Piecework prices and bonus on basis times are to be fixed by mutual arrangement, as is usual, but it is also provided that these prices and times are to be such as to enable a workman of average ability to earn at least 33⅓ over time rates, excluding war bonuses. An obvious comment on this agreement is that the employer, in order to obtain freedom to experiment with systems of payment by results, is either asked or is not unwilling to concede a great deal. Workers apparently cannot lose anything, but may, if they agree to give the changes in shop practice a fair trial, gain a great deal.

We have no desire to labour this aspect of the question. The important thing which it is desired to achieve at the outset is to convince large numbers of engineering and other employees that it is well worth their while to make a new experiment with piece rates on a vast scale. If the experiment is made honestly and with a real desire on both sides to ascertain the effect of the system in reducing the wages percentage of costs of production, then, we venture to suggest, a definite start will have been made with the work of resuscitating British industry. What is wanted more than all else at this juncture is an exhibition of good will and good faith by employers and employed in exploring methods by which the operation of our workshops at a far higher level of efficiency can be achieved. If that is given, British industry will have ground for hope of a happy issue out of its afflictions.

Electrical Structure of Matter.*

By Professor Sir ERNEST RUTHERFORD, D.Sc., LL.D., Ph.D., F.R.S.

It is my intention this evening to refer very briefly to some of the main features of that great advance in knowledge of the nature of electricity and matter which is one of the salient features of the interval since the last meeting of this Association in Liverpool.

The proof in 1897 of the independent existence of the electron as a mobile electrified unit, of mass minute compared with that of the lightest atom, was of extraordinary importance. It was soon seen that the electron must be of a constituent of all the atoms of matter, and that optical spectra had their origin in their vibrations. The discovery of the electron and the proof of its liberation by a variety of methods from all the atoms of matter was of the utmost significance, for it strengthened the view that the electron was probably the common unit in the structure of atoms which the periodic variation of the chemical properties had indicated. It gave for the first time some hope of the success of an attack on that most fundamental of all problems—the detailed structure of the atom. Our whole conception of the atom and of the magnitude of the forces which held it together were revolutionised by the study of radio-activity. The discovery of radium was a great step in advance, for it provided the experimenter with powerful sources of radiation specially suitable for examining the nature of the characteristic radiations which are emitted by the radio-active bodies in general. It was soon shown that the atoms of radio-active matter were undergoing spontaneous transformation, and that the characteristic radiations emitted, viz., the α, β and γ rays, were an accompaniment and consequence of these atomic explosions. The use of α particles as projectiles with which to explore the interior of the atom has definitely exhibited its nuclear structure, has led to artificial disintegration of certain light atoms, and promises to yield more information yet as to the actual structure of the nucleus itself.

It was early surmised that electricity was atomic in nature. This view was confirmed and extended by a study of the charges carried by electrons, α particles, and the ions produced in gases by X-rays and the rays from radio-active matter. It was first shown by Townsend that the positive or negative charge carried by an ion in gases was, invariably, equal to the charge carried by the hydrogen ion in the electrolysis of water, which was assumed, and assumed correctly, by Johnstone Stoney to be the fundamental unit of charge.

The idea of the atomic nature of electricity is very closely connected with the attack on the problem of the structure of the atom. If the atom is an electrical structure it can only contain an integral number of charged units, and, since it is ordinarily neutral, the number of units of positive charge must equal the number of negative. One of the main difficulties in this problem has been the uncertainty as to the relative part played by positive and negative electricity in the structure of the atom. We know that the electron has a negative charge of one fundamental unit, while the charged hydrogen atom, whether in electrolysis or in the electric discharge, has a charge of one positive unit. But the mass of the electron is only 1/1840 of the mass of the hydrogen atom, and though an extensive search has been made, not the slightest evidence has been found of the existence of a positive electron of small mass like the negative. In no case has a positive charge been found associated with a mass less than that of the charged atom of hydrogen. This difference between positive and negative electricity is, at first sight, very surprising, but the deeper we pursue our inquiries the more this fundamental difference between the units of positive and negative electricity is emphasised. In fact, the atoms are quite unsymmetrical structures with regard to the positive and negative units contained in them, and, indeed, it seems certain that if there were not this difference in mass between the two units, matter, as we know it, could not exist.

It is natural to inquire what explanation can be given of this striking difference in mass of the two units. I think all scientific men are convinced that the small mass of the negative electron is to be entirely associated with the energy of its electrical structure, so that the electron may be regarded as a disembodied atom of negative electricity. We know that an electron in motion, in addition to possessing an electric field, also generates a magnetic field around it, and energy in the electro-magnetic form is stored in the medium and moves with it. This gives the electron an apparent or electrical mass, which, while nearly constant for slow speeds, increases rapidly as its velocity approaches that of light. This increase of mass is in good accord with calculation, whether based on the ordinary electrical theory or on the theory of relativity. Now we know that the hydrogen atom is the lightest of all atoms, and is, presumably, the simplest in structure, and that the charged hydrogen atom, which we shall see is to be regarded as the hydrogen nucleus, carries a unit positive charge. It is, thus, natural to suppose that the hydrogen nucleus is the atom of positive electricity, or positive electron, analogous to the negative electron, but differing from it in mass.

There is the strongest evidence that the atoms of matter are built up of these two electrical units, viz., the electron and the hydrogen nucleus or proton, as it is usually called when it forms part of the structure of any atom. It is probable that these two are the fundamental and indivisible units which build up our universe, but we may reserve in our mind the possibility that further inquiry may some day show that these units are complex, and divisible into even more fundamental entities. On the views we have outlined the mass of the atom is the sum of the electrical masses of the individual charged units composing its structure, and there is no need to assume that any other kind of mass exists. At the same time, it is to be borne in mind that the actual mass of an atom may be somewhat less than the sum of the masses of component positive and negative electrons when in the free state. On account of the very close proximity of the charged units in the nucleus of an atom, and the consequent disturbance of the electric and magnetic field surrounding them, such a decrease of mass is to be anticipated on general theoretical grounds.

On the nuclear theory the hydrogen atom is of extreme simplicity, consisting of a singly-charged positive nucleus with only one attendant electron. The position and motions of the single electron must account for the complicated optical spectrum, and whatever physical and chemical properties are to be attributed to the hydrogen atom. The first definite attack on the problem of the electronic structure of the atom was made by Niels Bohr. He saw clearly that, if this simple constitution was assumed, it is impossible to account for the spectrum of hydrogen on the classical electrical theories, but that a radical departure from existing views was necessary. For this purpose he applied to the atom the essential ideas of the Quantum Theory, which had been developed by Planck for other purposes, and had been found of great service in explaining many fundamental difficulties in other branches of science. On Planck's theory radiation is emitted in definite units or quanta, in which the energy E of a radiation is equal to $h\nu$ where ν is the frequency of the radiation measured by the ordinary methods and h a universal constant. This quantum of radiation is not a definite fixed unit like the atom of electricity, for its magnitude depends on the frequency of the radiation. For example, the energy of a quantum is small for visible light, but becomes large for radiation of high frequency corresponding to the X-rays or the γ rays from radium.

In applying the quantum theory to the structure of the hydrogen atom Bohr supposed that the single electron could move in a number of stable orbits, controlled by the attractive force of the nucleus, without losing energy by radiation. The position and character of these orbits were defined by certain quantum relations depending on one or more whole numbers. Under ordinary conditions the electron in the hydrogen atom rotates in a circular orbit close to the nucleus, but if the atoms are excited by an electric discharge or other suitable method, the electron may be displaced and occupy any one of the stable positions specified by the theory. The problem is obviously much less complicated for hydrogen than for a heavy atom, where each of the large number of electrons present acts on the other, and where the orbits described are much more intricate than the orbit of the single electron in hydrogen. Notwithstanding the great difficulties of such a complicated system of electrons in motion, it has been

* British Association for the Advancement of Science, Liverpool, 1923. Presidential address.—Abridged.

possible to fix the quantum numbers that characterise the motion of each electron, and to form, at any rate, a rough idea of the character of the orbit.

These planetary electrons divide themselves up into groups, according as their orbits are characterised by one or more equal quantum numbers. It may be of interest to try to visualise the conception of the atom we have so far reached by taking for illustration the heaviest atom, uranium. At the centre of the atom is a minute nucleus surrounded by a swirling group of ninety-two electrons, all in motion in definite orbits, and occupying but by no means filling, a volume very large compared with that of the nucleus. Some of the electrons describe nearly circular orbits round the nucleus; others, orbits of a more elliptical shape whose axes rotate rapidly round the nucleus. The motion of the electrons in the different groups is not necessarily confined to a definite region of the atom, but the electrons of one group may penetrate deeply into the region mainly occupied by another group, thus giving a type of interconnection or coupling between the various groups. The maximum speed of any electron depends on the closeness of the approach to the nucleus, but the outermost electron will have a minimum speed of more than 1000 kiloms. per second, while the innermost K electrons have an average speed of more than 150,000 kiloms. per second, or half the speed of light. When we visualise the extraordinary complexity of the electronic system we may be surprised that it has been possible to find any order in the apparent medley of motions.

It is, possibly, too soon to express a final opinion on the accuracy of this theory which defines the outer structure of the atom, but there can be no doubt that it constitutes a great advance. Not only does it offer a general explanation of the optical and X-ray spectra of the atom, but it accounts in detail for many of the most characteristic features of the periodic law of Mendeléef. It gives us for the first time a clear idea of the reason for the appearance in the family of elements of groups of consecutive elements with similar chemical properties, such as the groups analogous to the iron group and the unique group of rare earths. The theory of Bohr, like all living theories, has not only correlated a multitude of isolated facts known about the atom, but has shown its power to predict new relations which can be verified by experiment.

While the progress of our knowledge of the outer structure of atoms has been much more rapid than could have been anticipated, we clearly see that only a beginning has been made on this great problem, and that an enormous amount of work is still required before we can hope to form anything like a complete picture even of the outer structure of the atom. We may be confident that the main features of the structure are clear, but in a problem of such great complexity progress in detail must, of necessity, be difficult and slow.

We must now turn our attention to that new and comparatively unexplored territory, the nucleus of the atom. In a discussion on the structure of the atom ten years ago, in answer to a question on the structure of the nucleus, I was rash enough to say that it was a problem that might well be left to the next generation, for at that time there seemed to be few obvious methods of attack to throw light on its constitution. While much more progress has been made than appeared possible at that time, the problem of the structure of the nucleus is inherently more difficult than the allied problem already considered of the structure of the outer atom, where we have a wealth of information obtained from the study of light and X-ray spectra and from the chemical properties to test the accuracy of our theories.

Experiments suggest that the hydrogen nucleus or proton must be one of the fundamental units which build up a nucleus, and it seems highly probable that the helium nucleus is a secondary building unit composed of the very close union of four protons and two electrons. The view that the nuclei of all atoms are ultimately built up of protons of mass nearly one and of electrons, has been strongly supported and extended by the study of *isotopes*. It was early observed that some of the radio-active elements which showed distinct radio-active properties were chemically so alike that it was impossible to effect their separation when mixed together. Similar elements of this kind were called "isotopes" by Soddy, since they appeared to occupy the same place in the periodic table. For example, a number of radio-active elements in the uranium and thorium series have been found to have physical and chemical properties identical with those of ordinary lead, but yet to have atomic weights differing from ordinary lead, and also distinctive radio-active properties. The nuclear theory of the atom offers at once a simple interpretation of the relation between isotopic elements. Since the chemical properties of an element are controlled by its nuclear charge and little influenced by its mass, isotopes must correspond to atoms with the same nuclear charge but of different nuclear mass. Such a view also offers a simple explanation why the radio-active isotopes show different radio-active properties, for it is to be anticipated that the stability of a nucleus will be much influenced by its mass and arrangement.

While we may be confident that the proton and the electron are the ultimate units which take part in the building up of all nuclei, and can deduce with some certainty the number of protons and electrons in the nuclei of all atoms, we have little, if any, information on the distribution of these units in the atom or on the nature of the forces that hold them in equilibrium. While it is known that the law of the inverse square holds for the electrical forces some distance from the nucleus, it seems certain that this law breaks down inside the nucleus. A detailed study of the collisions between α particles and hydrogen atoms, where the nuclei approach very close to each other, shows that the forces between nuclei increase ultimately much more rapidly than is to be expected from the law of the inverse square, and it may be that new and unexpected forces may come into importance at the very small distances separating the protons and electrons in the nucleus. Until we gain more information on the nature and law of variation of the forces inside the nucleus, further progress on the detailed structure of the nucleus may be difficult.

The nucleus of a heavy atom is, undoubtedly, a very complicated system, and in a sense a world of its own, little, if at all, influenced by the ordinary physical and chemical agencies at our command. When we consider the mass of a nucleus compared with its volume it seems certain that its density is many billions of times that of our heaviest element. Yet, if we could form a magnified picture of the nucleus, we should expect that it would show a discontinuous structure, occupied, but not filled, by the minute building units, the protons and electrons, in ceaseless rapid motion controlled by their mutual forces.

Before leaving this subject it is desirable to say a few words on the important question of the energy relations involved in the formation and disintegration of atomic nuclei, first opened up by the study of radio-activity. For example, it is well known that the total evolution of energy during the complete disintegration of 1 gramme of radium is many millions of times greater than in the complete combustion of an equal weight of coal. It is known that this energy is initially mostly emitted in the kinetic form of swift α and β particles, and the energy of motion of these bodies is ultimately converted into heat when they are stopped by matter. Since it is believed that the radio-active elements were analogous in structure to the ordinary inactive elements the idea naturally arose that the atoms of all the elements contained a similar concentration of energy which would be available for use if only some simple method could be discovered of promoting and controlling their disintegration. This possibility of obtaining new and cheap sources of energy for practical purposes was, naturally, an alluring prospect to the lay and scientific man alike. It is quite true that, if we were able to hasten the radio-active processes in uranium and thorium so that the whole cycle of their disintegration could be confined to a few days instead of being spread over thousands of millions of years, these elements would provide very convenient sources of energy on a sufficient scale to be of considerable practical importance. Unfortunately, although many experiments have been tried, there is no evidence that the rate of disintegration of these elements can be altered in the slightest degree by the most powerful laboratory agencies. With increase in our knowledge of atomic structure there has been a gradual change of our point of view on this important question, and there is by no means the same certainty to-day as a decade ago that the atoms of an element contain hidden stores of energy.

It may be urged that the artificial disintegration of certain elements by bombardment with swift α particles gives definite evidence of a store of energy in some of the ordinary elements, for it is known that a few of the hydrogen nuclei, released from aluminium for example, are expelled with such swiftness that the particle has a greater individual energy than the α particle which causes their liberation. Unfortunately, it is very difficult to give a definite answer on this point until we know more of the details of this disintegration.

On the other hand, another method of attack on this question has become important during the last few years, based on the comparison of the relative masses of the elements. This new point of view can best be illustrated by a comparison of the atomic masses of hydrogen and helium. As we have seen, it seems very probable that helium is not an ultimate unit in the structure of nuclei, but is a very close combination of four hydrogen nuclei and two electrons. The mass of the helium nucleus, 4.00 in terms of O = 16, is considerably less than the mass 4.03 of four hydrogen nuclei. On modern views there is believed to be a very close connection between mass and energy, and this loss in mass in the synthesis of the helium nucleus from hydrogen nuclei indicates that a large amount of energy in the form of radiation has been released in the building of the helium nucleus from its components. It is easy to calculate from this loss of mass that the energy set free in forming 1 gramme of helium is large even compared with that liberated in the total disintegration of 1 gramme of radium. For example, calculation shows that the energy released in the formation of 1 lb. of helium gas is equivalent to the energy emitted in the complete combustion of about 8000 tons of pure carbon. It has been suggested by Eddington and Perrin that it is mainly to this source of energy that we must look to maintain the heat emission of the sun and hot stars over long periods of time. Calculations of the loss of heat from the sun show that this synthesis of helium need only take place slowly in order to maintain the present rate of radiation for periods of the order of one thousand million years. It must be acknowledged that these arguments are somewhat speculative in character, for no certain experimental evidence has yet been obtained that helium can be formed from hydrogen.

If this view of the great heat emission in the formation of helium be correct, it is clear that the helium nucleus is the most stable of all nuclei, for an amount of energy corresponding to three or four α particles would be required to disrupt it into its components. In addition, since the mass of the proton in nuclei is nearly 1.000 instead of its mass 1.0072 in the free state, it follows that much more energy must be put into the atom than will be liberated by its disintegration into its ultimate units. At the same time, if we consider an atom of oxygen, which may be supposed to be built up of four helium nuclei as secondary units, the change of mass, if any, in its synthesis from already formed helium nuclei is so small that we cannot yet be certain whether there will be a gain or loss of energy by its disintegration into helium nuclei, but, in any case, we are certain that the magnitude of the energy will be much less than for the synthesis of helium from hydrogen. Our information on this subject of energy changes in the formation or disintegration of atoms in general is, as yet, too uncertain and speculative to give any decided opinion on future possibilities in this direction, but I have endeavoured to outline some of the main arguments which should be taken into account.

In watching the rapidity of this tide of advance in physics, I have become more and more impressed by the power of the scientific method of extending our knowledge of Nature. Experiment, directed by the disciplined imagination either of an individual, or, still better, of a group of individuals of varied mental outlook, is able to achieve results which far transcend the imagination alone of the greatest natural philosopher. Experiment without imagination, or imagination without recourse to experiment, can accomplish little, but, for effective progress, a happy blend of these two powers is necessary. The unknown appears as a dense mist before the eyes of men. In penetrating this obscurity we cannot invoke the aid of supermen, but must depend on the combined efforts of a number of adequately trained ordinary men of scientific imagination. Each in his own special field of inquiry is enabled by the scientific method to penetrate a short distance, and his work reacts upon and influences the whole body of other workers. From time to time there arises an illuminating conception, based on accumulated knowledge, which lights up a large region and shows the connection between these individual efforts, so that a general advance follows. The attack begins anew on a wider front, and often with improved technical weapons. The conception which led to this advance often appears simple and obvious when once it has been put forward. This is a common experience, and the scientific man often feels a sense of disappointment that he himself had not foreseen a development which ultimately seems so clear and inevitable.

Obituary.

EDWIN ROBERT WALKER.

A PROMINENT Lancashire engineer, Edwin Robert Walker, deputy chairman of Walker Brothers (Wigan), Limited, died on the 5th inst. at his home in Southport. Mr. Walker was born in 1848. He was one of five brothers and received his early education at Wigan Grammar School. After leaving school he served his apprenticeship to engineering at Haigh Foundry, Wigan, a business that is now out of existence. In 1869 he joined his brothers, J. S. and Thomas A. Walker, who had started a business at Queen-street, Wigan, which ultimately developed into one of considerable magnitude, necessitating a removal to Pagefield Ironworks, where it is still carried on under the well-known title of Walker Bros. (Wigan), Limited. Edwin Walker was mainly responsible for the management and mechanical developments, and had much to do with the design and construction of air compressors, blowing engines, &c., for colliery work. At a later date he applied his abilities to the construction of motor vehicles of the commercial type, a branch of the firm's activities which has been very successfully developed. During the war Mr. Walker threw all his energies into munition work, the Pagefield Ironworks being under Government control. The strenuous nature of this work ultimately led to a breakdown in his health, and after a long illness and operation he succumbed. Mr. Walker was a member of both the Institution of Mechanical Engineers and the Manchester Association of Engineers. He was made a county magistrate in 1913. He leaves a widow, son and daughter.

Electricity in Mines.

No. VIII.*

THE cascade type of motor is, of course, very suitable for use in mines and quarries, and it has made very rapid progress within recent years. The makers—Sandycroft, Limited, of Sandycroft, near Chester—claim that with the exception of the squirrel-cage motor, it is the only machine which strictly conforms with the Home Office regulations governing the installation and use of electricity in mines. The speed and starting torque are controlled by means of resistances connected to the stator windings, whilst the rotor is of the low-voltage short-circuited type, the construction being similar to that of an ordinary squirrel-cage rotor. Dangerous sparking is therefore impossible.

The illustration—Fig. 47—shows one of these

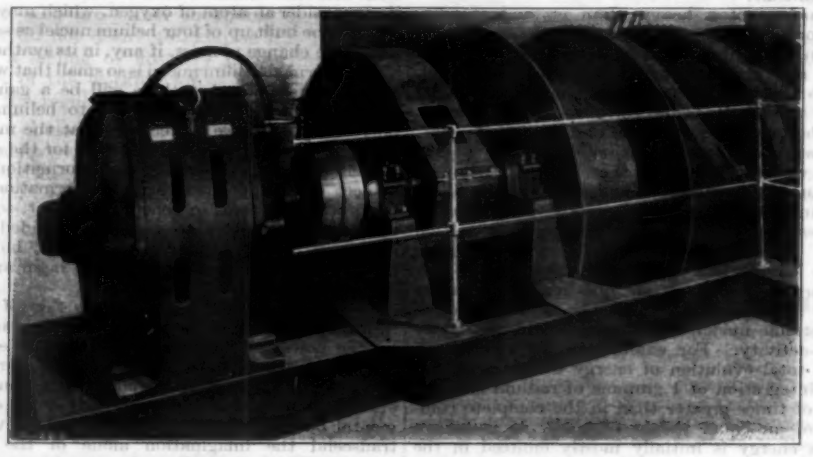


FIG. 47—CASCADE MOTOR DRIVING HAULAGE GEAR

machines driving a haulage gear. The motor is designed for an output of 100 brake horse-power, a speed of 500 revolutions per minute, and a periodicity of 50 cycles per second. For this class of work the cascade motor is claimed to be superior to the slip-ring motor, not only on account of the fact that it has a short-circuited rotor, but also because of the perfect control of the starting torque and speed. The machine starts without the least jerk and runs smoothly at speeds as low as 10 revolutions per minute when developing any torque up to 2½ times the normal.

The wear on the bearings is very slight, for as the rotor windings consist of several parallel circuits, there is no unbalanced pull when the rotor is out of the centre.

The machine—shown in Fig. 48—has been built

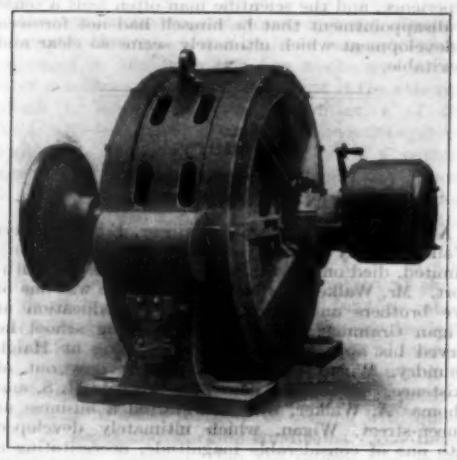


FIG. 48—CASCADE MOTOR

for driving a colliery fan. It is capable of developing 350 brake horse-power at 360 revolutions per minute, and 106 brake horse-power at 244 revolutions per minute, and is wound for a 2000-volt, 50-cycle, three-phase circuit. It has three slip rings, and on one side of the stator there is a short, circuiting switch for closing the tapping points on the parallel connected stator windings. As this particular machine is not required to run with resistances below 244 revolutions per minute, the starting is done with an ordinary liquid starting switch, which is connected to the rotor slip rings. A tachometer is provided for showing the speed of the machine. When it is desired to run at the low speed resistance is cut out of the rotor circuit until the approximate speed desired is reached, when the stator tapping switch is closed, and this allows the low-frequency currents, which are induced by the auxiliary rotor field, to circulate and cause the motor to run in cascade. The rotor resistance is then brought back to the "off" position, thus opening the slip-ring circuit.

Another of these cascade motors is shown in Fig. 49. This machine, which is for driving a Belliss compressor, is rated at 550 horse-power at 240 revolutions per minute, 275 horse-power at 120 revolutions per minute, and 184 horse-power at 83 revolutions per minute, and is wound for a 3300-volt, 50-cycle circuit. The machine is started by means of a liquid resistance connected to the three rotor slip rings exactly in the same way as the two-speed motor referred to above. In addition to the tapping switch a pole-changing switch is mounted on the stator, and by halving the number of poles the third speed is obtained.

A winding engine, driven by a two-speed cascade motor, is shown in Fig. 50. The use of a two-speed motor for the work reduces the peak load and the units consumed per wind. The saving is dependent upon the depth of wind, ratio of mass to gravity load, &c., and it therefore varies with the load conditions, but, on an average, the peak load is reduced by 25 to 30 per cent. as compared with the load of an ordinary motor, and the units consumed per wind are reduced by about 20 per cent. The cost of the equipment is but little more than that of an ordinary machine, and is said to be much less than that of a Ward Leonard equipment, although in many cases the overall efficiency is approximately the same. When required the second speed can be used solely for winding men at a rate of about two-thirds of the normal speed. For winders of moderate size con-

FIG. 49—CASCADE MOTOR FOR DRIVING AIR COMPRESSOR

tactor type switchgear is recommended, as the control is then practically automatic. In order to simplify control the stator is generally provided with two windings, and the second winding, which only carries the induced current, is under normal conditions only in circuit during the first stage of the acceleration, and has a small cross section. As the resistance of this winding forms part of the starting resistance, it has no effect upon the efficiency of the wind.

The motor—shown in Fig. 51—is a self-starting self-synchronising cascade motor, which is used to drive a colliery ventilating fan. It operates with a leading power factor of .7, and increases the power factor of the colliery to .9 or .95. Its output is 500 brake horse-power at a speed of 500 revolutions per minute, and is supplied with current from a 50-cycle, 300-volt, three-phase circuit. Exciting current is supplied to the stator windings by a direct-current exciter. Like all the Sandycroft cascade machines, it has a single core, in which both the main and auxiliary fields rotate, and there is a single winding on both the rotor and stator. The stator winding forms two star parallel-connected windings connected to the mains, and the exciter is connected between the two neutral points. The primary currents produce an eight-pole field, which rotates at 750 revolutions per minute. As the rotor runs at 500 revolutions per minute, there is a slip relative to the eight-pole winding of 250 revolutions per minute, and the frequency of the currents induced in the rotor is consequently 16⅔ cycles per second. This rotor current produces an auxiliary four-pole field, which on account of the construction of the winding, rotates backwards at a speed of 500 revolutions per minute and is carried forward by the mechanical movement of the rotor at the same speed. In space it is stationary and locks with the four-pole stator field produced by the exciter current. The rotor winding is of the same simple low-voltage short-circuit type as that of the cascade induction motor, and is practically indestructible. The motor works in two stages, and is equivalent to an induction motor connected in cascade with a synchronous motor. The rotor winding forms the link between the two stages, and is equivalent to an electrical flexible coupling which prevents shock when the motor synchronises.

The main weakness of the ordinary self-synchronising motor, the makers of these cascade machines point out, is the rotor winding, for in order to reduce the exciting current to a reasonable figure, the rotor must carry several wires per slot, and, therefore, when the machine is started as an induction motor very high voltages are generated and the slip rings and starting gear must be designed to withstand these voltages. In the cascade synchronous motor some of the slots carry two bars and the remainder only one bar, and as the winding is connected to form several parallel branches, only a very low voltage is generated under any conditions. Another advantage is the absence of slip rings and rubbing contacts. In these machines the whole of the stator winding is available for damping purposes, and as the synchronous element of a twelve-pole rotor has a four-pole field, the angular breadth of each pole is three times that of a motor of ordinary construction and of the same diameter. These two features combine to make the cascade machine extremely stable. We are told that it has been found impossible to make these machines hunt even under the most adverse conditions. Another interesting feature is the amount of excitation required by these machines. The rotor winding is equivalent to two windings, one producing eight poles and the other four poles, the latter having approximately half the number of bars possessed by the former. This relationship produces a slip-down effect in the excitation, as the rotor current produces twice as many ampère turns in the eight-pole element as it does in the four-pole element of the winding, with the result that the exciter is reduced to, approximately, one half of the size of a machine required by a twelve-pole motor of the ordinary type.

Probably there are still many who are unfamiliar with the principle of the cascade motor. A cascade induction motor is equivalent to two separate induction motors connected in cascade by coupling together the rotor windings. Similarly, the cascade synchronous motor is equivalent to an induction motor connected in cascade by coupling its rotor to the rotor windings of a synchronous motor having a stationary field. In the practical machines, there is only a single core which carries both fields, and there is a single winding both in the stator and rotor,

* No. VII. appeared September 7th.

but the motor works in two stages in exactly the same way as it would do if there were actually two machines.

If the rotor of an eight-pole slip-ring motor be connected to the rotor of a four-pole motor of the same type, and the shaft of the two machines be directly coupled, then the combination will run at a synchronous speed corresponding to twelve poles, or 500 revolutions per minute, on a 50-cycle circuit. The stator field of the eight-pole motor rotates at 750 revolutions per minute, and assuming that the slip causes the rotors to run at 490 revolutions per minute, the slip of the first machine will be 750 — 490 = 260 revolutions per minute.

The eight-pole field will, therefore, travel round

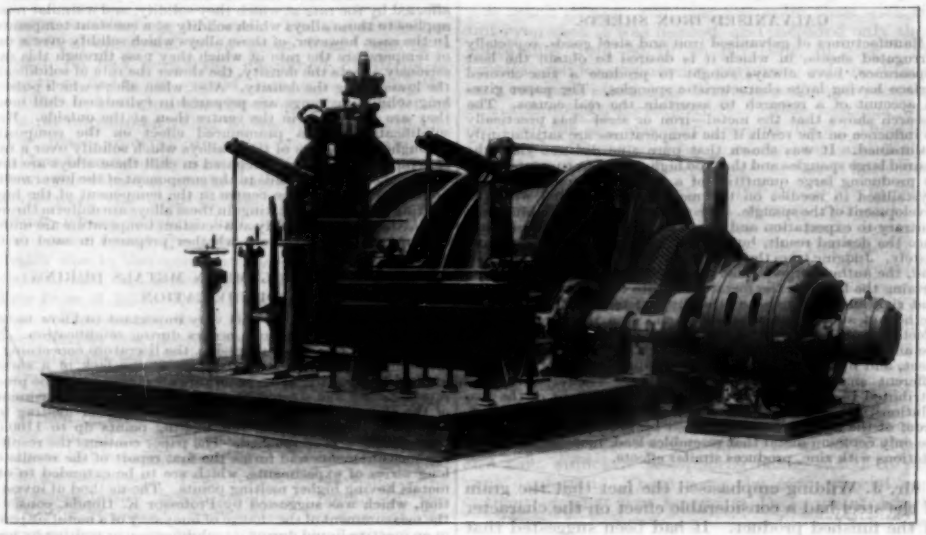


FIG. 50—CASCADE MOTOR DRIVING A WINDING ENGINE

the rotor at this speed, and the frequency of the rotor currents will be $\frac{260}{750} \times 50 = 17.3$ cycles. As the two rotors are connected together a current of this frequency will produce a magnetic field in the four-pole rotor, which will rotate round it at 520 revolutions per minute in a direction opposite to that of the mechanical rotation of the shaft, because the two rotor windings are connected so that the fields rotate in the opposite directions. It follows that as the magnetic field is rotating backwards round the four-pole rotor at 520 revolutions per minute, and is being carried forward mechanically at 490 revolutions per minute in space, the four-pole field is rotating backwards at 30 revolutions per minute, and at

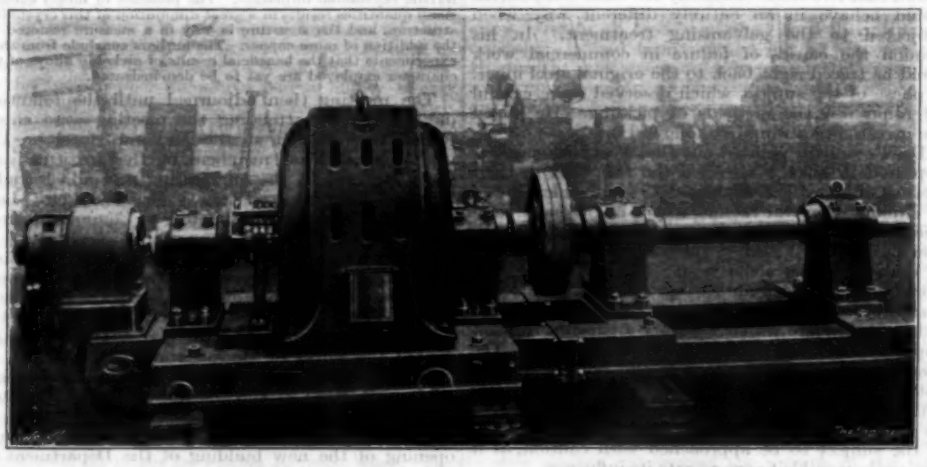


FIG. 51—SYNCHRONOUS CASCADE MOTOR FOR DRIVING FAN

this speed it cuts the four-pole stator windings, and induces a frequency in them of $\frac{30 \times 50}{1500} = 1$ cycle per second. At starting the four-pole stator winding is cut by the field rotating at 1500 revolutions per minute, and the frequency of the induced current is 50 cycles per second, and the rotor currents are then of the same frequency. The voltage induced in the rotor by the four-pole field is opposite to that induced in it by the eight-pole field, and, consequently, if the four-pole stator winding is open, the current that circulates in the rotor is only that necessary to produce the four-pole magnetic field. In other words, it is the open circuit current.

This four-pole magnetising current flowing through the eight-pole rotor windings is an eight-pole demagnetising current, and therefore the eight-pole stator winding draws from the line an equal and opposite current to the demagnetising current plus the no-load current required to produce the eight-pole magnetic field. This means that the line supplies both the eight and four-pole magnetising currents, the sum of the two being the no-load current of the machine. To start the machine the combination resistances are connected to the four-pole stator winding, thus enabling an induced current to flow. This current is balanced by an equal and opposite current in the four-pole rotor, and as this current also flows round the eight-pole rotor, a corresponding current is drawn from the line and it counterbalances it in the eight-pole stator windings. In doing this the strength of the four-pole field falls sufficiently to enable the extra rotor current to flow, and thus the flow of current throughout the combination is controlled by the starting resistance connected to the four-pole stator windings. The combination behaves in the same way as a slip-ring induction motor, but whereas the inductive action in the latter is only between the stator and rotor in the cascade motor, there is a further inductive action between the second rotor and the second stator, the flow of rotor current being controlled by the back electromotive force produced by the second field. Thus low-frequency induced currents flow in the second stator winding instead of in the rotor of the ordinary machine. As the machine runs up to speed the frequency of the currents induced in the second stator winding falls from full frequency at standstill to that corresponding to the slip at full speed, exactly as in the case of an ordinary motor. The voltage impressed on the rotor by the eight-pole field falls with the frequency from that corresponding to 50 cycles at standstill to that corresponding to 17.3 cycles at full speed, but the balance is maintained, because the back electromotive force induced by the four-pole field is proportional to the speed at which the four-pole rotor windings cut the four-pole field, and this rate of cutting is always proportional to the rotor frequency.

In the cascade motor there is only one core and one winding on the stator and rotor, but the core carries both eight and four-pole magnetic fields and the stator winding both the line current and the currents induced by the second field. The rotor winding is arranged so that the current produced in it by the action of the eight-pole field can also produce the four-pole field. The stator windings are grouped to form two parallel paths in each phase, and the starting or speed-regulating resistances are connected to points in this winding between which there is no difference of potential due to the line currents, but there is the full potential difference induced by the action of the four-pole rotor field. As the control of the rotor currents is due entirely to the counter electromotive force set up in the winding by the four-pole field, no connections are brought out from it, and it is consequently of the short-circuited type. As the two magnetic fields rotate in the same iron, effects are produced which are not met with in slip-ring motors. The most important of these is the absence of cogging during starting, and on account of this it is found possible to run the machines with resistances connected to the stator tappings at speeds as low as 2 per cent. of the full speed and with the machines developing anything up to twice the full-load torque. By providing the rotors with slip rings it is possible to prevent the windings producing the second field, and with the slip rings short-circuited the machine runs as an ordinary slip-ring motor. By arranging the stator windings so that the number of poles can be changed a third speed can be obtained. The principle of the synchronous motor is the same as that of the induction motor. It has been assumed in the case of the latter that the slip would reduce the full-load speed from 500 to 400 revolutions per minute. In the case of the synchronous motor, however, the rotor rotates at 500 revolutions per minute.

The Institute of Metals.

No. I.

AUTUMN MEETING IN MANCHESTER.

THE Autumn Conference of the Institute of Metals was informally opened by the lecture delivered on Monday night by Sir Henry Fowler, which is reported below, but the formal inauguration of the meeting took place on the morning of Tuesday, September 11th, in the Municipal College of Technology under the presidency of Mr. Leonard Sumner, when the Lord Mayor of Manchester (Alderman W. Cundiff) welcomed the visitors with a brief address, which was acknowledged by the President.

It was announced that the following new officers had been nominated for the year 1924–25:—President: Professor T. Turner. Vice-president: Professor C. A. Edwards. Members of Council: R. Lloyd Gibbins (Birmingham), Dr. H. Moore (London), A. J. G. Smout (Birmingham), Professor F. C. Thompson (Manchester).

The reading and discussion of papers was then proceeded with.

Mr. E. A. Bolton presented a contribution dealing with "The Cause of Red Stains on Sheet Brass."

RED STAINS ON SHEET BRASS.

The various theories regarding the cause of red stains on sheet brass which have been put forward are reviewed and experiments described which bear upon these theories. Although the experiments were carried out in the laboratory, close touch was established throughout with actual works practice. The outstanding point disclosed is that the stains actually occur through reactions of copper oxides in the scale formed during annealing and the pickling medium. Cupric oxide, contrary to the usual opinion, is shown to be as harmful as cuprous oxide. It is shown that oxides of copper may be present from various causes, such as careless washing after the pickling operation, resulting in the presence of acid and salts during the subsequent annealing, the presence of iron in the brass or upon its surface, the use of impure rolling oils, &c. It is concluded, however, that the main cause of the oxidation of the copper is the use of old-fashioned annealing furnaces in which the flames impinge directly upon the brass. The paper concludes with a brief account of possible remedies for the red stain trouble.

Opening the discussion, Professor Thomas Turner said that in many instances the production of red stains was of no importance, but in certain branches of the sheet metal trade considerable inconvenience and loss was occasioned by it. The subject was first investigated many years ago, and it was then thought that the cause of the staining was improper mixing or liquation of the copper. The work then done by Sir William Tilden lead to the adoption of the theory of dezincification, and the subject remained at that stage until Mr. Bolton took up the work. It had now been shown that taking a broad standpoint the red stain was produced by the deposition of copper in the pickling solution, and was the result of previous oxidisation. That was the fundamental explanation. It was interesting to see how closely this work was connected with the subject of corrosion, which appeared to be an entirely separate branch of study. The research into corrosion had indicated that what was formerly regarded as dezincification was really a re-precipitation of copper, and the red stains on sheet brass were produced in the same way. He hoped that the results of further work which was being carried out by Mr. Bolton would be laid before the Institute.

A paper on "Brinell Hardness Numbers" was then read by Mr. H. W. Brownsdon.

BRINELL HARDNESS NUMBERS.

This note draws attention to the desirability of authors expressing Brinell numbers for non-ferrous metals in figures that may be comparable. This is not a difficult matter, seeing that the desired result is obtained if balls and loads are used for which the ratio L/D^2 (the load in kilogrammes divided by the square of the ball diameter in millimetres) is constant. Dr. Brownsdon suggests that the choice for the large group of copper alloys with Brinell hardness numbers from about 40 to 200 should rest between the ratio 5 as standardised in the United States or the ratio 10 which is favoured in some quarters in this country.

Mr. R. H. Greaves pointed out that to make hardness numbers of different materials strictly comparable it would be necessary to preserve the same angle of impression. Fortunately, some variation about the mean angle of impression could be allowed without introducing any great error. The practice at Woolwich with a 10 mm. ball was to use an impression between 3 mm. and 4.5 mm. in diameter. This gave a range of hardness numbers with a 1000 kilos. load from 60 to 138, and could be extended to 200, which was about the limit possible with a 10 mm. ball. The rate of increase in the hardness number with decrease of diameter was about seven times as large at 2.5 mm. impression as before .5 mm. A gap between 500 kilos. and 3000 kilos. for the load was too large. One object in using a 500 kilos. load was to obtain a shallow impression on thin material, but the better method was to use a smaller ball. The author aimed at standardising not the load, but the ratio of L/D^2. It was impossible to expect to keep the impression within the ratio of 3 mm. to 4 mm. with a 10 mm. ball in the case of widely different materials such as copper and brass and steel. At the same time a ratio of less than 5 for a very soft alloy, or more than 50, should never be required, as the stress set up would be too severe upon the ball.

Dr. Walter Rosenhain sympathised with the desire to arrive at standardisation, but pointed out that this object must not be sought at the cost of hindrance to research work. It was a very attractive idea from the point of view of readers of papers to be able to express their results in comparable terms, but it did not follow that the comparison would be accurate as well as readily intelligible. It was important to remember that the test was subsidiary to the result which it was sought to achieve, and must be adapted to the material rather than to any arbitrary standard. His own idea was that it might be possible to standardise the ratio, not for all metals, but for certain groups of metals, and there was no very great object, if accuracy was to be sacrificed in the process, in wanting to compare the hardness numbers of materials of widely different character. Nor should it be overlooked that there were formulæ and methods by which the figures for different materials could be reduced to comparability.

Dr. Brownsdon, in reply, said his main object in drawing attention to the matter was to elicit the opinions of those who were interested, and he hoped that opinions would be sent in for publication in the "Transactions" by those who had not taken part in the discussion. If it could not be dealt with by that Institute, it might, perhaps, be handed over to the British Engineering Standards Association, so that an authoritative opinion might be obtained on the whole subject.

The next paper presented was that by Mr. A. H. Mundey and Mr. John Cartland on "Stereotyping." It was given in abstract by Mr. Cartland.

STEREOTYPING.

This paper describes the process of stereotyping, which is generally regarded by printers as one which is almost a trade secret. The authors point out that the process was invented by a practical metallurgist, William Ged, an Edinburgh goldsmith, in 1750. The evolution of stereotyping is traced from the plaster-of-paris process to the use of papier maché flong, and from the simple stereo plates for flat-bed machines to the elaborate requirements of the modern newspaper. The metallurgical difficulties are briefly dealt with and the consideration of metallurgists is invited to some of the problems involved. The authors urge that the industry is much more important than is usually understood, and they call attention to the high degree of accuracy demanded in the mechanical and metallurgical details.

Opening the discussion, Dr. Rosenhain said he had had occasion to inquire into troubles experienced in the stereotyping department of an important London newspaper some years ago, and was, therefore, interested in the subject. He was glad to hear that the industry had made so great an advance during a recent period, but he realised that there were still problems of considerable complexity to be solved. The quantity of metal involved in the daily operations of newspapers was very large, and it could not be doubted that the work which was being done was of considerable importance. The alloy actually used was a lead base, and, of course, not the most suitable for the purpose, but it was cheap, which was important from a newspaper point of view, and for that reason it was preferred to a tin alloy. There was no doubt that the printer was called upon to do a difficult thing in producing good castings out of material not the most suitable for the purpose. One would like to see a ternary eutectic used. He hoped that the study of the subject would be taken up seriously by some of the younger generation of metallurgists who were looking out for a subject for research. That research did not call for the use of expensive appliances, and was, therefore, one which might be selected where more complicated and expensive researches could not be undertaken.

Mr. A. H. Mundey, who replied on behalf of himself and his fellow-author, agreed as to the magnitude of the industry involved, which was unsuspected by most of the people who opened their newspapers at breakfast time. When trouble did arise with these alloys a remedy had to be found without delay. In Glasgow recently difficulty had occurred by reason of the plates not bedding down in the cylinder properly, with the result that the paper was cut. With regard to temperature control all the big printing houses were now putting in pyrometers and installing central control. He agreed as to the desirability of using a ternary eutectic, which would be much appreciated by the printer if it could be obtained at a reasonable price. Reference had been made to the manner in which the metal was ill-treated in printing works, but it was a curious fact that the metal seemed to respond to this ill-treatment. It was satisfactory to know that stereotyping work in this country had attained a level of excellence, which had not been approached by the printing industry of America or elsewhere.

Mr. E. L. Rhead then gave a short abstract of a paper by himself and Mr. J. Dickson Hannah on "Crystallisation Effect on Galvanised Iron Sheets."

GALVANISED IRON SHEETS.

Manufacturers of galvanised iron and steel goods, especially corrugated sheets, in which it is desired to obtain the best appearance, have always sought to produce a zinc-covered surface having large characteristic spangles. The paper gives an account of a research to ascertain the real causes. The research shows that the metal—iron or steel—has practically no influence on the result if the temperatures are satisfactorily maintained. It was shown that pure zinc did not yield the desired large spangles and that too high a temperature interfered by producing large quantities of a zinc-iron compound which crystallised in needles on the metal and interfered with the development of the spangle. The presence of tin or aluminium—contrary to expectation and as commonly stated—did not produce the desired result, but the addition of lead did so immediately. Judging from the known relationships between zinc and lead, the authors argued that the separation of the impure zinc forming the layer on the metal sheet into conjugate solutions—lead rich and zinc rich—at the dipping temperature, and the method of subsequent crystallisation, were the causes of the effects obtained. That this separation occurred was proved by the analysis of different types of spangle occurring on the same sheet, and by the observed differences in the rate of attack of different spangles forming the coating. The separation is attributed to the difference in the surface tensions of the two solutions. That such differences exist was proved by experiment. Proof of the hypothesis is furnished by the fact that bismuth, the only common metal that resembles lead, more or less, in its relations with zinc, produces similar effects.

Mr. J. Wilding emphasised the fact that the grain of the steel had a considerable effect on the character of the finished product. It had been suggested that it was necessary to add lead to the material, but speaking from his own experience he had found that there was always sufficient lead in commercial spelter to produce the spangled sheet. The temperature effect was important, and the figure mentioned in the paper was altogether too high to produce a good commercial article. It was necessary to keep the temperature down to 750 deg. Fah. It was also essential that the rolling strains should be taken out of the material, and careful attention must be given to methods of annealing. The whole question presented great possibilities to research workers, and he trusted that the Institute would help manufacturers to overcome some of their troubles.

Professor C. A. Edwards suggested that the paper dealing with research work in the United States which had been written by Mr. C. A. White should be consulted by those interested. It seemed clear that the composition of the steel was not the only factor to be taken into account, as experience had shown that two steels of exactly the same composition would behave in an entirely different way when subjected to the galvanising treatment. In his opinion the causes of failure in commercial work could be traced right back to the original steel ingot. A phase of the subject which deserved more careful attention was the methods of pickling. He hoped the investigation would be followed up.

Dr. Rosenhain pointed out that previous speakers appeared to have overlooked the fact that in their method of investigation the authors had endeavoured to eliminate several factors which might have complicated the issue by using sheet which had been previously galvanised. He had been interested in the subject for some years, and had carried out work with Sir Alfred Ewing on the remarkable character of the crystallisation in the case of an ordinary tin plate which was very analogous to what happened in the case of galvanised sheet. The spangled effect was not seen in tin, but all sorts of patterns could be brought out by remelting and chilling. Surface tension might have something to do with the effect produced, but it was an aspect of the subject to be approached with caution, as it was easily possible to exaggerate its influence.

Mr. H. T. Coe said that in galvanising works in South Wales there was a very general opinion that the presence of lead in spelter was favourable to the development of spangles in the galvanised sheet. So general was this belief that the spelter produced in Swansea, which contained over 1 per cent. of lead, was preferred by the galvanising industry. With regard to the influence of tin, the authors had dismissed that metal rather airily. It was thought in South Wales that tin to the extent of 1 per cent., or less, improved the spangle. A point to which Dr. Rosenhain had draw attention was the authors' use of galvanised sheet for their experiments. That seemed to him to be hardly a wise proceeding, and it would have been better to have used a different material for this work.

Mr. Hannah, replying to the discussion, said that neither he nor Mr. Rhead wished to contradict the statement that the quality of the steel was the principal factor in determining the quality of the spangle. With regard to the effect of lead, it seemed clear that it had a good deal to do with the production of a good sheet. On the general question he would point out that it was unwise to interpret laboratory experiments in terms of large scale work.

OTHER PAPERS.

The papers by Mr. R. C. Reader on "Effects of Rate of Cooling on the Density and Composition of Metals and Alloys," and by Mr. Hikozo Endo, on "The Measurement of the Change of Volume of Metals during Solidification," were, in the absence of the authors, taken as read, and will be discussed by correspondence.

THE COOLING OF METALS AND ALLOYS.

This note is concerned chiefly with two rates of cooling, fast and slow, as produced by casting in chill and sand moulds. The results recorded show that the densities of pure metals are not affected by the rate at which they solidify, and a similar remark applies to those alloys which solidify at a constant temperature. In the case, however, of those alloys which solidify over a range of temperature the rate at which they pass through this range seriously affects the density, the slower the rate of solidification the lower being the density. Also, when alloys which possess a long solidifying range are prepared in cylindrical chill moulds they are less dense in the centre than at the outside. Rapid solidification has a pronounced effect on the composition throughout the mass of those alloys which solidify over a range of temperature. When prepared in chill these alloys are found to be richer on the outside in the component of the lower melting point and richer in the centre in the component of the higher melting point. Sand castings in these alloys are uniform throughout. Alloys which solidify at a constant temperature are uniform in composition throughout whether prepared in sand or chill moulds.

CHANGE OF VOLUME IN METALS DURING SOLIDIFICATION.

In the casting process it is very important to know to what extent a change of volume occurs during solidification. Notwithstanding this great necessity, the literature concerning the phenomena is very scanty, because of the lack of a suitable method for arriving at an accurate determination. The present investigation was started in April, 1921, and the measurement of the change of volume during solidification or melting for a number of metals having low melting points up to 1100 deg. Cent. has now been finished. The paper contains the results of the measurements and forms the first report of the results of a long series of experiments, which are to be extended to other metals having higher melting points. The method of investigation, which was suggested by Professor K. Honda, consists in the measurement of the change of buoyancy of a metal suspended in an inactive liquid during its solidification or melting by means of a thermo-balance.

Mr. A. H. Mundey presented a paper by himself and Mr. C. C. Bissett on "The Effect of Small Quantities of Nickel upon High-grade Bearing Metals," and there was general regret that his appeal for an expression of opinion on this subject met with no response from the meeting. Doubtless, the paper will be discussed by correspondence.

NICKEL IN BEARING METALS.

A tough and well-reputed bearing metal was chosen for test, namely, the well-known alloy consisting of tin 93 per cent., antimony 3.5 per cent., copper 3.5 per cent. The results of the usual physical tests are detailed. Tensile, compression and hardness tests gave no indication of improvement due to the nickel; in fact, the alloys were rather inferior when containing nickel. Running trials on the Thurston machine on strictly comparative lines showed practically no change as between nickel and non-nickel alloys. The comparison of hardness at varying increased temperatures exhibited no improvement. Probably the most interesting feature is the structure as shown under the microscope. In the case of the alloy with no nickel the hard copper-tin constituent is very marked in its characteristic crystalline formation. The presence of nickel even in small quantities results in a great diminution of this crystalline structure, and the structure is only in a measure restored by the addition of more copper. The authors conclude from their experiments that the beneficial results of nickel in alloys of the character employed are yet to be demonstrated.

The meeting then adjourned until the following day. Members attending the meeting were entertained to luncheon at the Midland Hotel on the invitation of local members of the Institute and those engaged in the engineering and allied trades of the Manchester district. Mr. W. Clare Lees (President, Manchester Chamber of Commerce) occupied the chair.

In the afternoon visits were paid to the Trafford Park Estate Company, where arrangements were made for a short inspection of the works of the Metropolitan-Vickers Electrical Company, Limited, and the Ford Motor Company, Limited. Other parties visited the works of Mather and Platt, Limited, at Newton Heath, the Openshaw works of Armstrong, Whitworth and Co., and the works of the Broughton Copper Company, at Salford.

In the evening members participated in the formal opening of the new building of the Department of Metallurgy at the University of Manchester, of which a brief account is given on another page.

Sir Henry Miers, Vice-Chancellor of the University, presided, and the opening ceremony was performed by Sir George Beilby, who, in a brief review of the relation of research work to industrial progress, said that the new laboratory was the visible expression of the latest thought and practice in the production and manipulation of metals.

Mr. J. Phillips Bedson announced that Major Ernest Johnson, on behalf of the firm of that name, had decided to perpetuate the memory of Henry Cort, the inventor, by the gift of a medal to the new Department of Metallurgy, which would be known as the Cort Medal.

NON-FERROUS METALS IN ENGINEERING.

By SIR HENRY FOWLER.

The lecturer said he proposed to deal with copper and its alloys, with white metals, with

aluminium and its light alloys, and with one or two other non-ferrous alloys which were of especial interest to engineers.

Copper was the oldest used of the metals, and if engineers had lost the knowledge of how to use it as a cutting tool, it was because the need of this knowledge had also been lost. In spite of this disadvantage, copper still remained to-day the most important of the non-ferrous metals, and from an engineering standpoint was likely to remain so. In this country and in Europe generally, it was the metal chiefly used for locomotive fire-boxes and stays, and to a less extent for locomotive tubes; but the latter point was a highly controversial topic, which would be out of place in that lecture. In connection with the use of copper for the fire-boxes of locomotives, there was, however, no difference of opinion whatever amongst British locomotive engineers as to its being by far the most satisfactory material. The metal was, on the surface, subjected to a great heat, but he—although he had personally examined hundreds of locomotive fire-boxes—could not agree with Mr. Law, who in his admirable book on alloys said that "it is no uncommon thing to see the surface of the copper plate showing drops of copper where the metal has been actually melted." The troubles which lead to the removal of the plates of a locomotive fire-box were the wear at the sides, &c., and the cracking where bending had taken place, and in certain cases round the stud holes. The wear was probably due to the combined effect of erosion and oxidation, and had undoubtedly been diminished by adding from 0.35 to 0.5 per cent. of arsenic to the copper. The cracks were the result of repetition stresses, and by how much they were due to the presence of oxygen in the copper could not at present be stated. He could, however, say with the certainty derived from close and careful observation of practical results, that if the oxygen in a copper containing 0.35 to 0.5 per cent. of arsenic exceeded 0.15 per cent., the metal was liable to give trouble in the bending essential in manufacture. That was a point which was being scientifically investigated on behalf of the Non-ferrous Research Association by one of its Vice-presidents, to whom metallurgy as a whole owed so much—Dr. Walter Rosenhain.

The trouble with locomotive boiler work generally, however, rose not so much with the copper plate as with the copper stays which joined the inner copper to the outer steel plate of the fire-box. In times past there had been actual breakage, but owing perhaps to greater care in design, it did not occur often at the present day. What did happen was the gradual disappearance of the riveted head on the fire side. Many alloys had been tried for locomotive fire-box stays, but so far without displacing arsenical copper. One difficulty was that if an alloy harder than copper was used in riveting, it tended to spread and simply forced the copper plate out instead of forming a proper head.

Turning to bronze and brass alloys, Sir Henry suggested that the very word Bronze seemed to proclaim it as one of the aristocrats amongst alloys. It was the result of the alloying of two expensive metals, which put its use out of court when a cheap article was required. To engineers in particular it implied something which was sound, hard and reliable. It was employed in all our better-class fittings in connection with boilers and valves of all types. Few of the pure copper-tin alloys had a higher tensile stress than copper, whilst the elongation at once began to fall away as the percentage of tin increased. The most generally used bronze was that known as gun-metal, which usually contained about 10 per cent. of tin with small percentages of zinc and lead. The two latter had a great influence on the manufacturing properties. Zinc acted as a de-oxidiser, and gave castings freer from defects than when it was absent; whilst lead rendered the material much more easily machinable. Neither metal should, however, be present in a larger quantity than 2 per cent. The heat treatment of these copper-tin alloys was often of the greatest importance. Without going deeply into the subject, it might be said that there was only a slight effect at quenching after raising to less than 500 deg. Cent. At a temperature above that, however, although a higher tenacity and elongation might be obtained, the softer homogeneous structure which resulted might be unable to resist wear. He would like to take two instances which, although widely different, would illustrate that point. Some years ago at Derby a careful investigation on the subject of the composition of the slide valves used in Midland Railway locomotives was carried out. As there were at that time about 6000 valves in use, the question was of considerable interest. The work was carried out by Mr. Leonard Archbutt, and he had already given particulars of the results, but they would perhaps bear repetition. The composition of the alloy was copper 85, tin 14, lead 1, and it was found that the valves when subjected to a tensile test broke easily. When, however, the valves were raised above 500 deg. Cent. and quenched, they were found to be extremely tough. As a result, arrangements were made to deal with all valves in that way, but before they could be completed, it was found that the homogeneous metal that resulted wore so badly that the old method of using a sand cast was reverted to and was found to give satisfaction.

The second case ran on different lines. When the war broke out, there was at once a great demand for certain vehicles, in which the steel axles ran in a phosphor bronze pipe box, the composition of which was copper 88, tin 11, and phosphorus 1. He, knowing the Midland's foundry and machining capacity, undertook to make these, not only for the vehicles which the Midland Railway were supplying, but for certain other railways. The metal satisfied the mechanical tests, but was so hard that it was impossible to machine it. A method of heat treatment was, however, devised which produced the required quality of metal.

Continuing, Sir Henry said the copper-zinc alloys were more recent in date, but they covered an even greater range, and although bronzes could be worked at certain temperatures, they were less adaptable in that respect than the brasses. The range of alloys which were useful from an engineering standpoint was much greater with zinc variation than with tin, but even then it was limited, and included only those containing from 30 to 45 per cent. of zinc. The brasses used for engineering purposes could be divided into castings, stampings (hot pressed), and pressings and spinnings (worked cold). Brass castings were not used for any specially arduous duty. They had the great advantage of being easily cast, and if they contained a certain percentage of lead were very easily machined. A pure copper-zinc brass of 66-34 composition was tough and strong, but did not machine easily. The addition of lead, however, made it easy to machine and file, the lead lying between the crystals and forming planes of weakness which caused the metal to break up readily when being cut. It was a different thing when a metal was required that would work readily when cold. Recourse in such a case was had to Muntz metal. Only recently was full advantage being taken of the properties of such a mixture containing 60 per cent. of copper and 40 per cent. of zinc. A stronger and harder brass could be obtained by the addition of up to 2 per cent. of iron. The iron was introduced as an alloy of iron and zinc, sufficient phosphorus being added to prevent oxidation. These were the main special constituent of what was known as Delta metal, which, in addition to being strong and hard, could be worked either hot or cold.

A special alloy, which he believed had a great future before it, was the so-called manganese bronze, which was a brass containing 50–60 per cent. of copper, 35 per cent. of zinc, under 1 per cent. of manganese, and small percentages of tin, lead, iron and aluminium. It had a tenacity figure of 32 tons per square inch, with 30 per cent. elongation on 2in. It had been found most useful for axle-boxes liable to be hammered, but as it was soft, the metal must not be subjected to abrasion. Phosphorus had the great advantage of easily being introduced into an alloy, either as phosphor copper or phosphor tin. First and foremost, it was a de-oxidiser, and its reputation for producing sound, solid castings was well known, for it freed the alloy from the oxide and carried them with itself as phosphates into the slag. The wearing properties were proportional to the amount of phosphide of copper present, and the alloy hardened as the percentage of that constituent rose.

Bearing metals constituted another group. Broadly speaking, they consisted of tin-antimony-copper-lead alloys, and in all cases contained hard tin-antimony crystals. It had been pointed out by Mr. George Hughes that the success of a bearing metal depended more upon structure than composition, the proper distribution of a number of the tin-antimony crystals in a softer matrix of tin or lead being essential. The Association of Locomotive Engineers had decided years ago to adopt as temporary standards three white metals. No. 1 contained 85 per cent. of tin, 10 per cent. of antimony and 5 per cent. of copper, and had a Brinell number of 33; No. 2 contained 60 per cent. of tin, 10 per cent. of antimony, 2 per cent. of copper and 28 per cent. of lead, and had a hardness number of 20; No. 3 contained 75 per cent. of lead, 13 per cent. of antimony and 12 per cent. of tin, and had a hardness number of 19. Nos. 1 and 2 were used for bearings subjected to repetition stresses, while the lead base metal was suitable for more lightly loaded bearings in which the journal or shaft rotated only. Two points in the preparation of these metals were important—temperature of casting and impurities in the mixture. Casting under conditions which led to slow cooling encouraged the growth of the tin-antimony crystals, while too rapid cooling prevented their regular formation. For the high tin alloy, a good practical working temperature was from 375 deg. to 400 deg. Cent. The difficulty of impurities was a purely practical one, but was likely to occur in shops, which, like locomotive establishments, were largely engaged on repairs. All scrap metals when re-used were liable to be contaminated with impurities, and it was agreed that from 1.5 to 2 per cent. of lead would cause trouble in an alloy of that type. The Midland Railway Company had used a mixture of 83 per cent. copper, 9 per cent. tin, and 8 per cent. lead for locomotive axle bearings, and certain other railway companies had obtained satisfactory service from high zinc-bearing metals.

Aluminium was not being employed by the engineering industries in the way that its properties merited. It was true that aluminium by itself was not a satisfactory engineering material, but that was not the case with aluminium alloys. The binary alloys with zinc gave good tenacity with a fair elongation over a wide range, but binary alloys with copper did not give such good results. In practice, an aluminium-zinc-copper alloy had generally been used, and for aeronautical work the alloy which contained 7 per cent. of copper, 1 per cent. of tin and 1 per cent. of zinc had found a great deal of favour. The use of aluminium alloys for pistons would probably increase. The wrought alloys of that series offered great possibilities to engineers, and the well-known "Y" alloy was a material comparable with a good mild steel, with a specific gravity only slightly higher than that of pure aluminium. Material of this character should have a great future for reciprocating parts moving at high speeds.

In conclusion, Sir Henry said he would like to call attention to the work of the British Non-ferrous Metals Research Association. That Association was largely composed of firms connected with the production of non-ferrous metals, but included a number of engineering firms, and if it were strengthened in that respect its usefulness, which had already been proved, could be immensely increased.

Sixty Years Ago.

AERIAL navigation and submarine warfare were among the prominent subjects discussed in our issue of September 11th, 1863. The first-named subject was dealt with by Mr. Weldon in an article which we reprinted from Weldon's Register. To a modern reader the article is almost tedious to read in places, because it is devoted to proving that which now seems so obvious. Yet it deserves to be recalled, for it clearly foreshadows at that early date the coming of the dirigible. Mr. Weldon first demonstrated the impracticability of attempting to navigate the air by means of fitting power plant—a steam engine, of course—to a spherical balloon, his argument being that the air resistance of the gas-bag and the flexibility of the cords connecting it to the car containing the engine would render the scheme abortive. He next attacked the, then, only other alternative method proposed for constructing apparatus for aerial navigation the type of heavier-than-air machine which we now call the ornithopter, or flapping wing, device. By deduction from certain figures relating to the power exerted by a swallow in flight, he argued that before a flapping wing machine could be constructed with any prospect of being able to fly, it would be necessary to have at command a new source of motive power which would weigh less than a pound per horse-power. In passing it may be noted that a modern air-cooled aero-engine, such as the Bristol "Jupiter," weighs about 1.6 lb. per horse-power, but that the ornithopter is probably as far off practical realisation as it was sixty years ago. In spite of the unfavourable results of his investigations, Mr. Weldon still maintained that man could even then navigate the air without going outside the means at his immediate disposal without waiting, in particular, for a form of power plant other than the steam engine. He believed that it would be possible to accomplish the end if, instead of studying the birds, those interested in the subject would devote their attention to the fishes. By this process of thought he was led to draw a picture of a vessel containing the essential features of a modern airship, a vessel filled with buoyant gas and more or less shaped like a fish. The envelope, he said, was to be in the form of a flattened cylinder with paraboloidal ends, and was to be divided internally into a number of gas-tight compartments. Submarine warfare was dealt with in a leading article. If, in that article, the submersible warship was not foreseen, the development of the torpedo clearly was. It was a time, it must be remembered, when defensible armour plating had got the better of the gun. Artillerists were endeavouring to reverse matters, and it was clearly recognised that the time would come when they would succeed in doing so. For the moment, however, efforts were being directed towards getting behind the armouring by attack against the unarmoured portions of war vessels below the water-line. In the course of our leading article attention was drawn to Mr. Whitworth's recent proposal to discharge cannon from closed chambers filled with compressed air through portholes opening directly into the water, the submarine port to be open no longer than to afford sufficient time for the discharge of the shot. Scepticism was expressed mildly as to the practicability of this idea, and various others—all involving close quarters between the attacking and the attacked vessels—were suggested. One such scheme consisted of providing the attacking ship with horizontal double-acting steam hammers working through stuffing-boxes below the water-line whereby the enemy's hull might be pounded to pieces over the unarmoured portions. The object of the article, however, was not so much "to elaborate the details of submarine attack as to suggest how probably, if not how certainly, this mode of attack will be worked out to our loss by ingenious naval engineers."

ACCORDING to the Board of Trade returns, the value of the railway material exported during the seven months ended July 31st was as follows, the corresponding figures for 1922 and 1921 being added in brackets:—Locomotives, £1,762,708 (£3,054,709, £4,424,109); rails, £1,417,660 (£1,585,639, £1,828,962); carriages, £651,247 (£952,377, £899,818); wagons, £1,804,209 (£2,108,953, £3,425,245); wheels and axles, £593,192 (£847,199, £1,203,229); tires and axles, £304,851 (£266,472, £913,598); chairs and metal sleepers, £525,567 (£1,422,821, £761,963); miscellaneous permanent way, £656,286 (£894,559, £1,660,199); total permanent way, £3,680,611 (£5,144,075, £6,520,520). The weight of the rails exported was 158,271 tons (154,287 tons, 82,900 tons), and of the chairs and metal sleepers, 46,732 tons (101,465 tons, 30,328 tons). During July alone the value of the locomotives was £191,687, of which those shipped to India accounted for £98,113.

Internal Combustion Engines Exhausting into Low-pressure Turbines.*

By Lieutenant-Colonel F. MODUGNO.

The Compound Combustion Engine.

Engineers have for some time past been endeavouring to increase the power developed by internal combustion engines and to improve their efficiency; and many researches have been directed towards finding a solution by compounding the expansion in a manner similar to that adopted in steam engines.

The present paper deals with compound expansion, and particularly with that obtained by utilising in low-pressure turbines the exhaust gases from the cylinders. It is believed that this may be of interest to the members of the Institution in view of the steadily increasing importance of the internal combustion engine for the propulsion of ships.

In an internal combustion engine the exhaust gases leave the cylinder at a pressure slightly higher than atmospheric, which fact causes the loss of a part of the expansion work.

In Fig. 1 the cycle $a\,b\,c\,d$ shows the transformations which take place in a Diesel-type engine with gradual combustion. In order to avoid the loss previously referred to the expansion should be extended beyond the point d, to the point h, so that the diagram of the work would become $a\,b\,c\,h$, and be limited by two lines of constant pressure $b\,c$ and $h\,a$ and by two curves $a\,b$ and $c\,h$, which should, theoretically, represent two adiabatic transformations. There would then be a cycle having, in excess to the Diesel cycle, the area $d\,h\,a$; and as the quantity of heat used in the two cases during the combustion stage $b\,c$ would remain the same, the theoretical efficiency of the new cycle would increase, in comparison with the Diesel cycle, in the same proportion as the respective areas.

In order to realise such a cycle, which we shall call "Constant pressure cycle"[1] (although the words "constant pressure" could not exactly be used to refer to a closed cycle, but to a transformation), it would be necessary to have in the cylinder a compression stroke much shorter than the expansion stroke. But in practice the result would not be so favourable, as, for a given quantity of compressed air in the cylinder and for a given quantity of fuel burnt, the resulting volume of the cylinder would be considerably larger than that of the Diesel cylinder, being no longer measured from the abscissa of point a, but from that of point h; the dimensions and weight of the engine would increase and especially the work of friction. Finally, the mean effective pressure in the cylinder would diminish, the maximum remain unaltered, the mechanical efficiency would be very low, the result being that the motor would develop less effective power and have a lower efficiency than that of the Diesel motor of smaller dimensions.

In order to avoid these disadvantages it has been thought wise to adopt compound expansion in a high-pressure and a low-pressure cylinder with the object of limiting the high pressure to one cylinder of comparatively small capacity only, while the walls of the other cylinder, being subjected to a much lower pressure, could be of reduced thickness, thus reducing its weight while adhering to the larger capacity. Similarly the pistons, the connecting-rods, the crank shaft and the frame would come out lighter than they would be if the whole cycle takes place in a cylinder of the same volume as the low-pressure cylinder.

The first experiments in this direction were made in 1879 with gas motors, followed at a later date, in 1896, by others with Diesel motors; the results, however, were always unfavourable for the following reasons:—

In order that the net output of work from the low-pressure cylinder may be kept within a reasonable proportion to that absorbed by the frictional resistance, it is necessary that the exhaust pressure of the gases from the cylinder, in which the combustion takes place, shall not be inferior to a given limit; in this case, however, their temperature would be so high as to render necessary the adoption of water-cooled exhaust valves with a consequent considerable loss both in temperature and pressure, thus reducing considerably the area of the work diagram in the low-pressure cylinder. On the other hand, the lubrication of the high-pressure cylinder will become a difficult problem in view of the high temperature prevailing there, notwithstanding the adoption of a very thorough system of cooling.

In general, for the above reasons compound motors have given in practice inferior results to those obtained from single-expansion engines, with the drawback of a greater complication in their structure.

A new compound engine has been recently built by Mr. Elmer A. Sperry in America, but from the particulars published only improvements in details have been observed as compared with earlier motors of the kind, and, therefore, it is probable that the results will not be very different.

The Exhaust Turbine.

The difficulties and disadvantages mentioned for compound motors are being overcome in the greater part by the substitution of a turbine for the low-pressure cylinder. In fact, as the turbine is better suited than a compound engine to utilise efficiently a small fall of pressure, the gases can be further expanded in the high-pressure cylinder, thus arranging for the greater part of the work to be carried out there. In this way the temperature of the exhaust gases would be lower and the mean temperature in the high-pressure cylinder would also be reduced.

Further, the weight of the turbine is considerably less than that of the corresponding low-pressure cylinder, as the former need not be dimensioned in proportion to the volume of the exhaust gases. The idea of using a low-pressure turbine in conjunction with a reciprocating motor is not novel; it has already, as is well known, been extensively applied in the aircraft motors with brilliant results. Aircraft motors develop constantly decreasing power with an increase of height, as the quantity of air introduced in one stroke becomes less and less and a correspondingly small amount of fuel can, consequently, be burnt. It has, therefore, been suggested to overload the motor by first compressing the air by means of a rotary compressor so as to force a greater weight of air into the cylinder.

The compressor is coupled to a turbine driven by the exhaust gases of the motor, and the combination has power enough to compress the quantity of air necessary for combustion up to a pressure, approximately, equal to that of the exhaust gases; keeping this pressure constant at one absolute atmosphere by suitable means the motor will develop at any height the same shaft-power as that developed at sea-level. In this manner it has been possible to reach far greater heights than those previously attainable by motors not fitted with superchargers; at great height also the speed of the aeroplane is increased, as the power remains constant while the resistance of the medium is decreased.

This favourable result is due to the special circumstance that, the turbine and compressor being so proportioned as to obtain the exhaust of the gas and the introduction of the air into the cylinders at the pressure of an absolute atmosphere, the working conditions of the motor remain unaltered; at low heights the motor acts with direct exhaust and both the turbine and the compressor are idle. As the height increases the work of the turbine-compressor-combination increases proportionately to the increase of height, thus maintaining unaltered the limits of pressure between which the motor acts, and the diagram of the work in its cylinder as well. In other words, there is no real supercharging, as the motor always retains its normal load, which is not affected by a reduction of pressure in the surrounding atmosphere. Fig. 2 shows the work diagrams; the isobars $m\,g$ and $n\,h$ correspond, respectively, to the pressure of an absolute atmosphere and to the pressure of the air at the height at which the motor works. The diagram of the work in the cylinder is always given by $f\,b\,c\,l$, whatever the altitude of the aeroplane may be. The diagram of the compressor is shown by $n\,a\,f\,m$, that of the turbine by $m\,g\,h\,n$. Therefore, taking the efficiency of the compressor-turbine combination as one, the increase of work would be given by the area $f\,g\,h\,a$; in practice, however, the efficiencies are not sensibly higher than one-half of that, and it has been ascertained that the effective power developed by the turbine is only sufficient to keep the compressor working. Should the efficiency of the two engines be so low as to render the power of the turbine not sufficient to work the compressor, it would be necessary to raise the exhaust pressure into the turbine above the inlet pressure of the compressor.

The first tests of superchargers for aeroplanes were carried out in France in 1917, but before that time it had been proposed to apply a similar system to any internal combustion engine. Ing. W. Schmidt[2] proposed, indeed, to divide the work of an internal combustion engine in a high-pressure cylinder and in a low-pressure cylinder or in a turbine; he further subdivided the compression by raising the air to the pressure of 2–4 atmospheres in a separate compressor before letting it into the high-pressure cylinder. The power developed in the low-pressure cylinder, or in the turbine, is utilised for keeping the compressor in motion, so that the external work is only done by the cylinder in which the combustion takes place.

The system proposed by Mr. Schmidt, therefore, corresponds exactly to that shortly afterwards adopted in aeroplane motors; this can be shown in the same diagram—Fig. 2—by assuming the line $a\,h$ to correspond to the pressure of an absolute atmosphere and the line $f\,g$ to the pressure of 2–4 atmospheres.

The Compound System with Extended Expansion in the Cylinder.

The following system differing in many points from that put forward by Mr. Schmidt, is suggested by the author:—

Fig. 3 refers to an engine with gradual combustion.[3] According to the Schmidt system the cycle in the cylinder is given by $f\,b\,c\,l$, that in the turbine by $m\,g\,h\,n$, that in the compressor by $n\,a\,f\,m$. Let us now imagine that the expansion of the gases burnt in the cylinder is not stopped at l, but extends to point d, which corresponds to the abscissa of point a, also that the exhaust gases expand along the line $d\,g$ until they reach the inlet pressure of the turbine. The cycle thus resulting in the cylinder will consist of the combustion line $b\,c$, of the expansion line $c\,d$, of the exhaust line at constant volume $d\,e$, of the exhaust line at constant pressure $e\,f$, and of the compression line $f\,b$. The work diagram will, therefore, be increased by the area $l\,d\,e\,f$ as compared with the diagram of the Schmidt system. No alterations will be noticed in the cycles of the turbine and of the compressor; the total work developed for a given quantity of heat generated during combustion is, therefore, greater, and the theoretical efficiency is correspondingly raised.

By comparing this system with a normal Diesel engine, we shall find a diminution of work in the cylinder measured by the area $a\,f\,e$, and outside of the cylinder the negative work of the compressor $n\,a\,f\,m$ and the positive work of the turbine $m\,g\,h\,n$; thus leaving altogether a positive difference measured by the area $e\,g\,h\,a$ and resulting in a higher theoretical efficiency than that of the Diesel engine. Neglecting the triangular loss $d\,g\,e$, which is unimportant when the inlet pressure into the turbine is not much lower than that at the end of the expansion in the cylinder, the complete diagram of the work is given by $a\,b\,c\,h$, and coincides with the cycle we have called "Constant pressure cycle." It is, however, to be borne in mind that, while in our case the volume of the cylinder is measured by the segment $i\,a$, in the case of the constant pressure cycle, which takes place in one cylinder only, the volume of the latter would be given by the segment $i\,h$, which is much greater.

The system worked out by Mr. Schmidt will, henceforth, be called "Standard compound system," and that proposed by the author, being characterised by a greater expansion of the gases in the cylinder, will be called "Compound system with extended expansion in the cylinder," or shortly, "Extended expansion system." The manner in which the extended expansion system can be realised in practice is very simple in the case of a four-cycle engine. The cycles in the cylinder proceed in the usual manner as in a common Diesel, the only difference being the raising of the exhaust line produced by the insertion of the turbine. At the beginning of the exhaust the pressure drops suddenly in accordance with the line $d\,e$, and the exhaust proceeds then at constant pressure as shown by the line $e\,m$. At the end of the stroke, when the suction valve opens, the pressure is again rapidly lowered, thus causing the suction line $n\,a$ to drop below the exhaust line. The compression, which takes place entirely in the cylinder, commences at a and is followed by the combustion and expansion, as in the Diesel engine with direct exhaust. No separate compressor is, therefore, required for the preliminary compression, and no alteration is necessary in the usual arrangement of the Diesel engine. Therefore, any four-cycle Diesel engine can, without substantial alteration, be associated with a turbine on the compound system with extended expansion.

In the case of a two-cycle engine, however, some alterations to the normal Diesel type are necessary, and the compressor cannot be dispensed with, as the exhaust of the burnt gases and the introduction of the air into the cylinder take place simultaneously, and the scavenging air must necessarily have a higher pressure than that of the exhaust gases. Besides, in order to avoid, in the two-cycle engine, the compression above the exhaust line commencing in the cylinder before point f, its distribution will have to be suitably modified. Two alternatives are possible. There may be fitted in lieu of the ordinary exhaust ports, which are uncovered by the piston at the end of the stroke, or, better still, in addition to the above ports, an automatically controlled exhaust valve on top of the cylinder closing when the piston reaches the position corresponding to point f in the diagram, thus allowing the escape of the combustion gases during the part $e\,f$ of the return stroke of the piston. In this case the air inlet valve should open at the bottom centre or shortly after and close at the same time as the exhaust valve. The second alternative is more simple and, therefore, perhaps preferable; it consists in arranging for the scavenging to take place at the bottom centre in the usual way and for the closing of the scavenging valve to be suitably retarded, so that the scavenging air may, after filling the

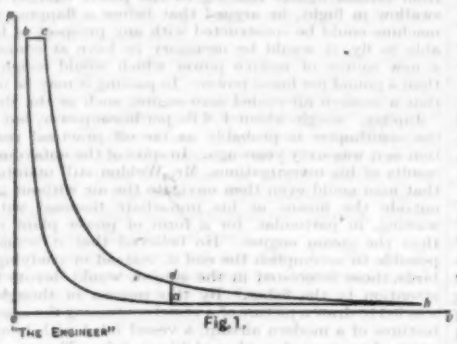


Fig. 1.

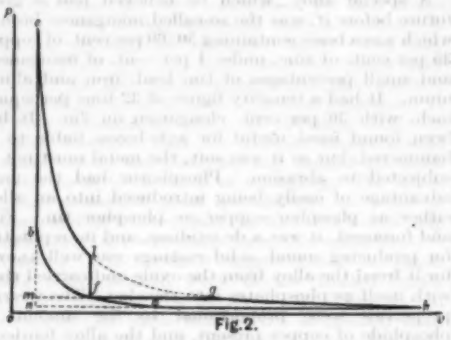


Fig. 2.

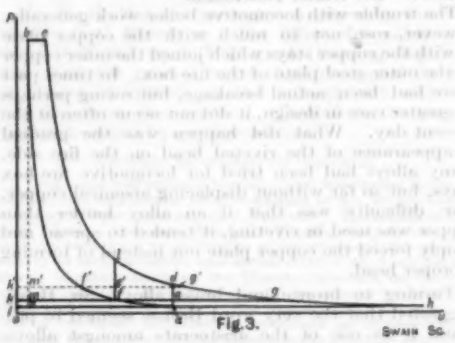


Fig. 3.

* Institution of Naval Architects, 1923.

[1] This wording corresponds to the German expression "Gleichdruckverfahren."

[2] W. Gentsch: "Die Verwertung der Abwärme von Brennkraftmaschinen für Kraftzwecke (*Zeitschrift des Vereines deutscher Ingenieure*, November 25th, 1916, page 982).

[3] Henceforth the considerations refer to Diesel type motors; these can, however, be similarly applied to other types of explosion and gradual combustion motors.

cylinder, be partly expelled from the cylinder during the fraction $e f$ of the return stroke of the piston, without causing any compression to take place before point f.

It has been seen how in the case of the four-cycle engine the preliminary compression can take place in the combustion cylinder itself. It is, however, also possible (but not more convenient) to have the preliminary compression carried out in a separate compressor, in which case the cycle in the cylinder would become $e f b c d$, and the air inlet valve should close at f, as in the two-cycle engine.

Reverting to the comparison of the standard compound system with the extended expansion system we observe that in the first case the volume of the cylinder is shown in the diagram by the segment $i a$, viz., equal to the volume of the corresponding Diesel cylinder with direct exhaust to the atmosphere, while in the second case the volume is reduced to $k f$. As the quantity of air introduced into the cylinder is equal in both cases, it appears that the second cycle is supercharged, while this is not the case for the first cycle.

In the standard compound system the ratio of compression in the cylinder must be logically smaller than that obtained both in the Diesel with direct exhaust or in the four-cycle system with extended expansion, in order that the pressure at the end of the compression stroke may remain the same as in the other two cases. With equal ratios of compression the resulting pressure and temperatures in the cylinder would be extraordinarily high and far above practical convenience. But, even supposing an equal maximum pressure, the working conditions of the cylinder in the standard compound system are far more difficult than in the Diesel with direct exhaust and in the extended expansion system; in the first case, indeed, both the mean pressure and temperature are considerably higher. This circumstance is a serious inconvenience for the internal lubrication, and reduces the lasting qualities and the safety of the parts subjected to greater wear, higher thermal and mechanical stresses. Another serious drawback is caused by the higher temperature of the exhaust gases at the moment at which the exhaust valve opens (point l of the diagram), so that the latter could hardly stand without being directly water cooled, thus involving, as already stated, a great loss of heat.

In conclusion, the standard compound system, compared with the extended expansion system, shows the following drawbacks:—It necessarily requires a compressor, involves several constructional rearrangements of the Diesel type and presents serious difficulties in the design, construction and on service; on the other hand, for a given power a smaller cylinder volume is required, and as for a given maximum pressure the resulting mean pressure is higher, it allows a greater power to be developed for a given weight of material used in the construction. It is also to be noted that the extended expansion system is liable to be supercharged, with a resulting further increase in the exhaust pressure. If, for instance, it be desired to reduce the dimensions of the cylinder to those of the standard compound system (which means stopping the expansion in the cylinder at point l), it would be necessary to carry the exhaust line from $e m$ to $e' m'$, e' being any point on the segment $f l$.

In this case it will be convenient to have the compression ratio in the cylinder reduced as in the standard compound cycle (and even further reduced in the case of a two-cycle motor), and it will also be necessary to introduce a compressor for the preliminary compression of the air. The preliminary compression cycle will be shown by $a f' m' n$, and will take place entirely in the compressor in the case of a two-cycle engine; while in the case of a four-cycle engine the part below the line $m f$ will take place in the compressor, and the part above the same line in the cylinder. The work in the turbine will be shown by the diagram $m' g' h n$. The extended expansion system with supercharging, compared with the standard compound system, shows a theoretical increase of efficiency determined by the increase $e' g' g f$ in the area of the work diagram.

CONCLUSION.

In an Appendix, which we do not reproduce, the theory of the Diesel motor exhausting into a low-pressure turbine is considered, and the efficiencies of the different systems which have been considered are compared. From the calculations made we may draw the following conclusions:—

(1) Supercharging cannot be adopted without a considerable loss of efficiency.

(2) Of the non-supercharged systems the compound one with extended expansion can give a profit in efficiency of 4 per cent. compared to the engine with direct exhaust; this, however, would perhaps not justify the greater complication of the addition of the turbine, as it may be only obtained under certain conditions of load and working.

(3) The two supercharged systems are equal as regards the necessary arrangements, as both require a compressor and a turbine, while the extended expansion system differs from the standard compound system only by the greater exhaust pressure into the turbine. But in the first case the loss of efficiency in comparison with the simple direct-exhaust engine is from one-third to one-fourth lower than in the second case. It is, therefore, convenient, when an overload is required, to select the cycle with extended expansion in the cylinder.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—A special conference has been arranged at the Shipping Exhibition at Olympia, on September 19th, under the auspices of the Institution of Automobile Engineers, when three papers dealing with internal combustion engines applied to marine purposes will be read, as follows:—11.30 a.m., "Reversing Systems of Large Marine Oil Engines," by Miss V. Holmes; 2.0 p.m., "Small Commercial Marine Motor Design," by Arthur F. Evans; 4.30 p.m., "Small Marine Engine Design," by Basil H. Joy. The secretary of the Institution of Automobile Engineers will be very glad to send tickets for any or all of the above meetings to those interested, on application to him at Watergate House, York-buildings, Adelphi, W.C. 2.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improvement Maintained.

THOUGH the autumn revival in business in iron and steel is slow in making itself manifest in the Midlands, the improvement in the market tone noted last week continues. September has so far brought no great extension of business, but with August left behind manufacturers and consumers are facing the last quarter of the year with more confidence, and the nervous tension of the market has been to some extent relieved. Buyers are not sufficiently confident to arrange future business, but in this they are in agreement with producers, who are not disposed to sell considerable tonnages at the present unremunerative prices. With current demand so small there is a general distrust of the prevailing level of prices, and the primary aim in both the productive and distributive branches is to run on as fine a margin of stock as possible. Notwithstanding the endeavour to keep output down to the limits of consumptive demand, a good many producers of raw materials have larger stocks than they can see any chance of liquidating in the near future unless a real buying movement sets in. True specifications have been reaching manufacturers on a somewhat more encouraging scale from customers at home, and values in some departments are a little steadier. There are, however, still evidences of keen cutting of prices. Except in the galvanised sheet department of the market the desolation which has fallen upon the Eastern Empire has made no perceptible effect.

Galvanised Sheets for Japan.

Galvanised sheets continue very active, with steady booking of orders, and mills are well situated for work. Prices are, if anything, firmer, and this is attributed to the urgent requirements of Japan coinciding with a brisker inquiry for India and the Argentine. Prices are not materially raised, but a good deal of business is being put through at £18 15s. f.o.b. for 24-gauge corrugated, and thinner gauges in proportion. Shipments are being hurried forward for Japan. They are needed to cope with the immediate situation, and if sufficient supplies of the thin gauges which serve for roofing in Japan are not forthcoming, it is expected that consignments of 24-gauge will be sent. Black sheets are in improving demand at £13 10s.

Manufactured Iron.

In the finished iron branch of Staffordshire industry there is not much change. The quotation of £10 15s. for nut and bolt bars is being shaded where there is a prospect of securing business by so doing, but the foreigner has increased his advantage from a price point of view. No. 3 Belgian iron has been reduced to £8 12s. 6d. delivered in this district. Staffordshire nut and bolt iron is nearly helpless against this competition. Where malleability is essential the Staffordshire mill usually gets the business, but where the local manufacturers can utilise the variable foreign bar moderately heavy orders go to the Continent. Marked bar mills remain fairly active, and the £14 10s. standard is easily maintained. Crown bars have not deviated from the £12 line, and merchant iron continues to be sold at anything from £11 10s. to £11 15s. per ton.

Steel.

There is moderate activity in the steel trade in the Midlands, and more stability has been achieved in the price of billets and heavy rolled steel. There is, however, a good deal of price cutting in such products as steel tube strip, angles and small bars. Cleveland structural steel prices have now come down to the Midland basis of £9 10s. for angles and joists, and £10 10s. for tees, and comparative uniformity has, therefore, been restored. One large Staffordshire steel works which stopped lately has resumed operations, and is issuing weekly rolling lists to Birmingham consumers. In the finished department it is possible to buy Belgian joists at £7 12s. 6d. f.o.b. Antwerp, equal to £8 17s. 6d. delivered, against the home price of £9 10s. Angles costing £9 delivered offer some little advantage against the native material. But the purchase of this material is affected by the question of delivery, which for foreign steel is frequently not sufficiently expeditious for the requirements of engineers, builders, &c., a recent example being the delay of three months in the shipment of a parcel of bars. Reasonably prompt delivery is often a vital matter to constructional engineers, and native mills, in spite of their higher prices, are getting most of the business in finished steel. In the semi-finished branch the tendency is for the low offers, which have recently threatened further disintegration of the market, to be withdrawn. Soft billets are still to be bought at £7 15s., but an increasing number of steel works are asking £8 for their product. Foreign competition in billets has decreased considerably, and quotations received this week for some thousands of tons was on the basis of £7 12s. 6d.—an advance of half-a-crown—at the customer's railway station, which would be equal to £7 15s. delivered, exactly the price quoted by many Midland steel works. The stagnation in heavy steel scrap is unrelieved, the quoted prices being unacceptable to consumers.

Raw Iron.

The pig iron position shows slightly more activity, and, after a long period of stagnation, ironfounders are reappearing with a few orders. Prices, nevertheless, are still shaded, lower than £4 12s. 6d. being accepted for Derbyshire and £4 10s. for Northamptonshire foundry numbers, while North Staffordshire material is now down to £4 15s. Staffordshire ironmasters are taking more interest in forge iron, but are placing business only at prices which show a decided reduction on recent figures. Northamptonshire forge is now quoted £4 2s. 6d. and Derbyshire £4 4s., but these are regarded by buyers as the maximum. Smelters, it is said, who are anxious to get rid of as much of their stock as possible, are willing to meet consumers in the matter of price, and in some cases prices well below those mentioned above have been accepted. Output has been further reduced by the stoppage of two furnaces in the Lincolnshire area, with which the Midland district is intimately associated, and it is considered that production is now fairly balanced by the actual consumption of material.

Fuel.

Supplies of furnace coke are coming forward a little more freely, partly on account of the reduced blast-furnace demand. Blast-furnacemen continue to express disappointment over the continuance of coke at 26s., this being a solid factor which would have helped them out of an uneasy corner if a lower figure could have been arrived at. Some consumers state they can see no possibility of improvement in business while coke remains at its present price. Something like £1 per ton is the figure named as being likely to give smelters a chance.

American Foundrymen at Coventry.

The delegates of the American Foundrymen's Association, who on the 6th inst. visited Coventry, were favourably impressed with the methods of production in operation at the works they inspected. They were entertained by the Coventry and District Branch of the Institute of British Foundrymen, and were taken over the Daimler works, the manufactories of the British Piston Ring Company, Limited, and Sterling Metals, Limited. An interesting member of the delegation was Mr. George Wadsworth, of Akron City, who served his apprenticeship in Wolverhampton nearly half a century ago. "Taking methods of production as a whole," said this gentleman, "yours compare very favourably with ours."

Increasing Unemployment.

The step in the right direction to which I referred in my last letter has not been maintained in the unemployment returns, and this week I have to record an increase of, in round figures, 1500 in the number of unemployed in the Midlands, the total being 171,245, as compared with 169,733 a week previously. This aggregate is made up of 124,780 men, 4827 boys, 35,735 women, and 5903 girls. There were slight increases in Cradley Heath, Dudley, Hanley, Longton, Northampton, Nottingham, Stourbridge, and West Bromwich. In Birmingham there was an increase of 712.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THE general condition of the iron and metal markets is not much changed, and in some departments there is rather a deeper depression, while in others it is said that a better feeling prevails. Probably this irregularity is caused by the differing opinions as to the effect of the Japanese earthquake. It is believed by some people that there will be an era of rapid reconstruction, which will cause a demand for vast quantities of material. This is the optimist view; and, on the other hand, there are the pessimists who believe that so enormous a destruction of property cannot fail to have disastrous financial effects. It is too early yet to determine which view is the more likely to be correct. The very uncertain condition of politics on the Continent is a point for those who take the gloomy view of the situation.

Metals.

The slight improvement in the copper market which occurred about a week ago has not gone any farther, and the feeling here has been rather inclined towards depression. Of course, it is recognised that copper prices are low, so far as standard and refined ingots are concerned, but consumers here do not yet think that there is any danger in working on low stocks. The belief seems to be that, although there may be minor fluctuations, any general rise in copper prices is yet a long way off. One supposes that this belief is based on the poor state of industry throughout Europe and the improbability of any revival this year. Germany, however, continues still to import copper in spite of the chaotic condition of her exchanges. Her total imports for the last half year were over 50,000 tons. In Manchester merchants report only a small business in copper. Engineers do not seem to be buying very freely, and it is generally understood that with some exceptions the mechanical engineers of this district are not too well employed. Otherwise there would be a better demand for castings. The attitude of dealers in old metals is usually a very good test of the condition of the copper market, because when there is any sufficient consumption of metals scrap dealers are always very eager to buy. At the present moment, on the contrary, one finds them more than usually indifferent, and the prices they offer in this district are well below the intrinsic value of the old metal. Some dealers will now pay only £45 per ton for gun-metal scrap; others pay £46, but the latter price is enormously below the value of the metal. In yellow brass it is the same, the dealers' prices for buying being a good £15 below the intrinsic value. In the market for tin, experts seem now to be very chary of expressing any definite opinion one way or the other. The price of tin has moved upwards with some steadiness by about £25 per ton since the beginning of July, but it is still rather below the April and May prices. The statistics of the metal are very favourable just now, there being a substantial decrease in the visible supplies amounting to not far short of 2000 tons; but the question is whether this better statistical position

has not been discounted in the prices. The market for lead has been very firm, and some rise in the price has taken place. Lead prices are, however, dangerously high. Spelter has also been a strong market with some slight increase in the quotations. In both these markets the opinion seems to be favourable at the present time.

Pig Iron.

The demand for foundry pig iron in Manchester and the district is again rather restricted, and it is noticeable that the slight disposition to buy forward has disappeared. This means, of course, that the consumer is not so much convinced that the prices are really at the bottom; and the reason for the disturbance of this belief is no doubt to be found in the fact that the Cleveland makers have again reduced their price to 97s. 6d. per ton on trucks. This does not directly affect the Manchester market, but it tends to weaken confidence; especially as Cleveland prices are now approaching a point where they may compete with Derbyshire iron in some parts of Lancashire. Derbyshire makers still base the price of foundry iron in Manchester upon 92s. 6d. per ton at the furnaces; but it is rumoured that some of these furnaces are accumulating stock; although there are others which appear to be selling all their make. There is a weakness also in North Staffordshire iron, and this, owing to a lower rate, affects Derbyshire sales here. It is said by some merchants here that if a good order for Derbyshire were offered on a basis of 90s. at the furnaces it could be placed. Meantime there is no reduction in the cost of making pig iron, either in the Midlands or in Cleveland, and while this is the case the prices cannot come down quickly. Scotch iron is rather easier, but there is now so little business being done in it here that it is difficult to test the prices.

Steel.

The demand for finished steel in this district shows no improvement, but prices are fairly well maintained. Sellers of steel plates have endeavoured to keep the price at, or near to, £10 per ton; and sellers of joists and angles at £9 5s.; but there are reports from steel works in other districts of much lower prices. It is really very difficult to say at what lowest price one could buy manufactured steel.

Scrap.

There have been some reports of a better demand, both in Sheffield and in South Wales, for steel scrap, and slightly higher prices have been talked of; but this scrap has been so much depressed that a slight rise is not much to boast of. The demand for heavy wrought scrap from the ironworks is moderate, but the prices offered are unchanged at 75s. to 77s. 6d. per ton. Foundry scrap is quiet at from 80s. to 85s. per ton delivered to the foundries.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite iron market, which recently showed a gleam of hopefulness, is dark again, the better trade reported having been a flash in the pan. It may be that the present recurrence of a slump is momentary, or it may be that the quietness is setting in for some time; it is exceedingly difficult to tell in these days. If it were not for Sheffield and the Midlands generally trade would be very dull indeed. The Scotch buyers are standing off, and very little business is being done as compared with normal times. The boilermakers' dispute may be affecting this branch of the market. Neither South Wales nor the Continent shows any life, and the latter has fallen back very considerably of late. The rates of exchange are interfering with this business. As far as America is concerned, the prospect of better trade does not seem to have developed as it was hoped it would. Some orders came along and it was thought that others might follow; but they have not, and the combined result is that practically the whole of the smelters in the North-West are having to put iron into stock. If the outlook in the steel trade were better, there are firms which would consume all the balance of iron smelted. Unfortunately the steel departments are not so favourably situated. Generally speaking, the iron trade is low and one may hear of more furnaces being damped down.

Iron Ore.

The iron ore trade is very poor in tone and the outlook is a bad one for many of the miners. It is a case of short time with reduced hands in many mines, and with others it means complete stoppage. It is to some extent only the mines owned by smelters which are doing the most. The Oldbarrow mines are only working short time with a reduced number of workers. Foreign ore is not coming in in quantity, and as stocks exist at the docks it is not likely to do so.

Steel.

The steel trade is not as good as it was—and it has not been good for some time. Notices have been posted at Barrow with regard to the rail and merchant mills, and when they have expired the engagements will be from day to day. This is a result of orders being exhausted, and future activity depends upon more orders being booked. The position in Workington is about the same as at Barrow. The hoop and small section mills at Barrow are experiencing better business. Foundries are only moderately well employed.

SHEFFIELD.

(From our own Correspondent.)

The Decline in Heavy Steel.

THERE is no need to repeat in detail what has been said during recent weeks of the falling off in orders for heavy steel. The absence of buying continues, and, although the basic furnaces are still turning out a large tonnage, they are not so busy as they were. The month of August was the worst recorded for many years. Figures are now available as to the steel output for July, and they show a great falling off. The production in the Sheffield and Rotherham district was 61,000 tons, including 31,000 tons of acid, 21,500 tons of basic, and 2500 tons of Bessemer acid. The total represents a decline of nearly 40,000 tons on the figures for June, and a reduction of 3000 tons on July of last year. The output in Lincolnshire was 40,000 tons, all basic, a drop of 10,000 tons on the month. The production of pig iron in Lincolnshire was well maintained, amounting to 67,000 tons, which was a reduction of only 3000 tons on June. There were 19 furnaces in blast.

Railway Work.

One of the strongest sections of local industry continues to be that which is engaged in the manufacture of railway axles, tires, and springs. The amount of work on hand now exceeds that of pre-war years, although it is not sufficient to provide full employment for the plants, which have been greatly extended. Now orders still come in, and a continuance of business is fully expected. A railway order of the week, which is of much interest, though it will not directly affect Sheffield, is one which Cammell Laird have booked for the supply of 77 motor and trailer coaches for the Great India Peninsular Railway, in connection with the scheme for the electrification of the Bombay suburban lines. The new coaches will be similar in design to those recently constructed by the firm for the same railway. The work will be carried out at Messrs. Cammell's Nottingham branch.

Departmental News.

There is only a moderate amount of work in the tramway track departments, which have to meet formidable competition from America in some of the overseas markets. Orders from the shipbuilding yards are very meagre, and the engineering branch, with the exception of the electrical side, is quiet. Local makers of engineering tools, such as stocks and dies, twist drills, milling cutters, and files, are not doing well, although the file trade is reported to be improving somewhat. There is but little work at the steel foundries. Belgium is a severe competitor in castings, and is helped by the low rate of exchange, as a result of which that country is able to supply our engineers with castings at prices which home founders cannot rival. The tool steel trade, although still very badly placed, is not quite as depressed as it has been. There is a good demand for strip and wire. There is a movement in the right direction in joiners' and builders' tools, edge tools, saws, spades and shovels, and kindred lines.

How Trade is Handicapped.

Some interesting things with regard to the growth of charges to industry has to meet were said at the annual meeting of the Sheffield Forge and Rolling Mills Company last week by Mr. C. E. Siddall, the chairman. The company's operations last year resulted in a loss of £18,475, and Mr. Siddall said that the high cost of production, chiefly wages, had been the main adverse factor. In the past twelve months the firm paid £54,000 more in wages than in 1914, with a much smaller output. To get wages down was the chief concern at the moment, but he could not see how it was going to be done until the cost of living came down. While agreeing that something should be done for unemployed workmen, he considered that the dole was very badly applied, and that due inquiries were not always made before it was granted. Recently, when he was on the Bench, several youths were charged with gambling. Not one of them had done a stroke of work in his life, but they were each drawing 15s. a week dole. Mr. Siddall also mentioned that the firm was paying £4000 more in municipal rates than in 1914, £4000 more in insurance, and £22,500 more for fuel. He added that in all his forty years' experience he had never known such reckless and unsound competition as they had had during the last six months. There was no necessity for it. He spoke of the heavy burden of national taxation, and said that industry had been bled financially white by Government interference.

Effect of the Earthquake.

It is feared that the earthquake in Japan will have a serious and immediate effect on Sheffield trade. That effect may be counterbalanced eventually by sales of steel for rebuilding purposes, but at the moment loss instead of gain is anticipated. Sheffield has for years past done a very considerable trade with Japan, especially in tool steels of both the best and the cheaper kinds, and several firms carried in that country extensive stocks of valuable material. It is feared that these, or a large part of them, may have been destroyed. The extent to which trade has been carried on means, of course, that considerable sums of money are outstanding, and, as it is possible that many of the customers have perished in the catastrophe, the question of collecting the debts is naturally causing much anxiety.

Cutlery and Plate.

The volume of trade in cutlery during August showed a reduction. The ordinary export branch is at a low ebb, but a fair amount is being done with some of the Colonies. The trade in cheap goods keeps up surprisingly well, and firms supplying material to the small makers state that the demand is on a large scale. The handle makers are doing very well, which shows that a large quantity of table cutlery is being turned out. Nearly the whole of this is of the stainless variety. For butchers' knives, shoe knives, and knives used in other trades, there is a fair demand. The electro-plate industry continues to supply large quantities of spoons and forks and cased goods, of low prices, but the general trade shows no improvement. A few firms are, however, beginning to secure orders in connection with the coming Christmas season, and it is hoped that, now that the holidays are over, a revival of buying will take place.

The Development of Motor Traction.

The extent to which the motor is displacing the horse, thereby making stronger road surfaces necessary, is shown by the very interesting results of a traffic census recently taken in Sheffield by the City Surveyor—Mr. W. J. Hadfield. The weight of traffic has grown enormously since 1913-14, when the last census was taken. In that year the heaviest traffic was 6284 tons per day, which passed along Blonk-street. Now there are seven thoroughfares carrying over 10,000 tons per day, while 16 others carry from 5000 to 10,000 tons. An increase of 150 to 200 per cent. in the average daily tonnage is frequent, while in three cases the increase is from 353 to 393 per cent. In 1913-14 the average proportion of heavy motor traffic—*i.e.*, motors weighing with load 5 tons or more—was 13 per cent., but now it is 56 per cent. The increase of this class of traffic, which is likely to be further accentuated both as to the number of vehicles and heavier individual weights, is, says Mr. Hadfield, the real problem which confronts road engineers. The total number of counts dealt with in the census returns is 69, and in only seven of these does horse traffic amount to 25 per cent. or more, while in the 1913-14 counts it represented 63 per cent. of the total traffic. In 26 of the 69 counts, horse traffic represents less than 10 per cent. of the total weight, in some cases getting down to 3 or 4 per cent. With one exception, the streets with 25 per cent. or more of horse traffic are comparatively level, and are mostly central streets. Animal traction is being confined more and more to short journeys over easy gradients, while motors are used for journeys of substantial length, and for hill work. Another point to which the city surveyor calls attention is the great increase of traffic on the popular outlying roads, and the use that is being made of the new arterial roads for the relief of other and busier roads.

Electricity Extension.

The Rotherham Corporation has greatly extended its electricity undertaking during the last year or two, with a view to supplying large quantities of current for industrial and other purposes. The new station in Rawmarsh-road, which was formally opened by the Prince of Wales three months ago, is of very large capacity. An interesting development has now taken place in the shape of a supply of power in bulk to the Yorkshire Electric Power Company for use at the Orgreave Colliery. The "take off" from the Rotherham service is at Templeborough. This is the beginning of a new scheme, and in the near future may lead to important extensions outside the borough.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE hoped-for autumn expansion of business has not yet materialised. The home foundries and engineering trades, which are the chief consumers of pig iron, remain very slack, and as prices have been tending steadily downwards for months past consumers adhere to a strictly hand-to-mouth policy in regard to the purchase of pig iron supplies. The export trade is almost equally slack from totally different causes. The chaotic state of European currencies makes it very difficult to finance purchasers on the British markets, and the Ruhr invasion has delivered a knockdown blow to many European industries. Thus the market for iron is very restricted at home and abroad, and even after a drastic curtailment of the output of pig iron in this district it is by no means certain that production does not outstrip demand. At all events, makers hold large stocks, and various ways and means have been discussed to liquidate them. There is little iron going to Scotland, but even yet Cleveland iron, with transport charges added, is dearer than the Scottish iron produced on the spot. Prices are maintained, No. 1 being 103s. 6d., No. 3 G.M.B. Cleveland 97s. 6d., No. 4 foundry 92s. 6d., and No. 4 forge, mottled and white, 90s.

Hematite Pig Iron.

There are indications of a slightly improved tone in the hematite pig iron trade, and a blast-furnace, which had been producing Cleveland iron, has been transferred to hematite production. A number of sales are reported, including one of 1000 tons to France, and there is a slightly firmer tendency in prices. It might still be possible to place a substantial order for mixed numbers at 98s. 6d., but the general market quotation is fully 99s. per ton, and some makers ask up to 100s.

Ironmaking Materials.

Business in the foreign ore trade shows no signs of expansion. Under normal circumstances the continuance of the strikes at Bilbao and Hornillo Bay and the generally disturbed state of Morocco would have created serious apprehension about the ore supply; but there is such a glut of ore at all the works, owing to diminished consumption, that consumers welcome any opportunity of delaying deliveries under contract. Merchants are vainly offering best Rubio ore at 23s. per ton c.i.f. Tees. The coke market is as firm as ever, good medium furnace qualities being quoted from 40s. to 41s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Although business in the manufactured iron and steel trade continues quiet, at the moment the outlook is regarded as more promising. There seems every probability that Japan will soon be in the market for large quantities of steel for reconstruction purposes, and British steel manufacturers are probably best situated to meet the demand when it arises, although no doubt the Americans will be keen competitors. The most encouraging feature of the trade is the exceptionally heavy demand for galvanised corrugated and black sheets, and it is stated that some of the works have orders in hand to keep them

fully employed for some time to come. Quotations are unchanged all round.

The Coal Trade.

There is no great volume of business passing in the Northern coal trade for this month, as the bulk of the prospective output has been placed, and the supplies now available are solely in second-hand dealers' hands. The latter, although taking an optimistic view of the prospects, are still showing some eagerness to get rid of any surplus stocks while prices remain on the present level. The feeling as regards the forward prospects shows a wide divergence of view, and while collieries look forward to a continued satisfactory volume of business, merchants are not quite so hopeful, and are anticipating a reaction. The anthracite miners' strike in the United States is practically settled, while the Italian and Greek political situation has cleared, so that no fillip in the demand from these quarters is now expected. From other sources the inquiry is only on moderate lines. Northumberland steam coals are fairly steady for every brand of screened sorts, both bests and seconds. Steam smalls are a shade steadier. Durham gas coals are fairly well upheld, as is also the case for coking of all brands. Bunkers are quiet, but unchanged in value. The coke market shows no activity, and stocks are increasing. Values, however, are maintained.

Canadian Contract for Tees-side Firm.

Ashmore, Benson, Pease and Co., of Stockton-on-Tees, gas plant manufacturers, have secured a contract in face of keen American competition for a tank and gasholder for the Montreal Light, Heat, and Gas Company, to be erected at a cost of over £100,000. The order is for a steel tank 230ft. diameter and 41ft. deep, and a four-lift gasholder to work in the tank, with guiding frame complete, of a capacity of eight million cubic feet of gas. The contract includes erection complete at the Villa-la-Selle Works of the Montreal Company. The steel material will be manufactured on Tees-side.

New Docks on the Tyne.

The Middle Docks and Engineering Company, Limited, South Shields, which was formed in 1900, has just completed an extensive scheme of extending and reconstructing its graving docks. Two new docks have been built, while Nos. 1 and 2 docks have been reconstructed. No. 4 dock is 315ft. in length, 48ft. wide at the entrance, and 18ft. deep at the sill at high tides. No. 3 dock is 460ft. in length, No. 4 dock 630ft., and No. 2 dock has been lengthened to 406ft. All the docks are now connected to one central pumping station.

SCOTLAND.

(From our own Correspondent.)

Export—Brighter Prospects.

SPEAKING in a general sense there seems to be a better tendency in the export trade. Foreign markets are becoming more interested in home products, and hopes are entertained that a more normal situation will be established before long. In most cases producers are prepared to offer the lowest possible prices to overseas buyers, and already some advantage has been taken of such inducements. Whether the business reaped will justify the inducements or not remains to be seen.

Home Markets Lifeless.

The continuance of the dispute at the shipyards largely accounts for the lack of interest in home markets. The shipbuilding industry on the Clyde and elsewhere is practically at a deadlock, and the influence on other industries in the west of Scotland is far-reaching. Until the boilermakers' dispute is at an end there seems little hope of a general revival in the home trade. There have been indications that business is waiting to be placed, but until conditions are normal again nothing of any consequence is likely to be done. Contracts have been reported, but the work on these must of necessity be held up meantime.

Orders for the Clyde.

Orders for two liners, each of 15,000 tons deadweight, have been placed with Barclay, Curle and Co., Whiteinch, on behalf of the P. and O. Steam Navigation Company. It is understood that the builders will also provide the engines, which are to be of 11,000 indicated horse-power. The latter should help to relieve the present unemployment to a certain extent, at any rate. Other contracts are rumoured, and if placed may compensate in a measure for those lost through the boilermakers' dispute.

Lord Weir on the Situation.

Speaking at the annual dinner of the Clyde Trust, Lord Weir made the following reference to the boilermakers' dispute:—"Was it too much in reference to unemployment, to expect that we could help ourselves by cutting out the costly extravagance of labour stoppages? Was it impossible to bring home to the Boilermakers' Society the national responsibility they were incurring and the grievous harm they were inflicting on other wage-earning sections? If the boilermakers cannot appreciate their responsibility, and they have been given ample time—then I am tempted to say: Is it impossible to train boilermakers? Are the shipbuilders content to drift instead of to steer? When faced with an abnormal situation—and surely the situation of the shipbuilding industry to-day is an abnormal one—then it ought to be met by abnormal measures."

Steel and Iron.

The situation in the Scotch steel and iron trades is more or less unchanged. Buying is extremely limited. Only immediate requirements are entertained, and these are of necessity for almost negligible quantities. The hope of still lower prices may also be a reason for restricted buying, but it is questionable if there is much business hanging fire meantime from that reason. Steel makers remain short of orders for plates and sectional material, the recent price reductions having brought no apparent advantage. Sheets of the lighter gauges remain the only bright spot, and in these a steady turnover is maintained for export. Galvanised sheets, too, are also fairly busy. Any movement in bar iron is slow in the extreme, and re-rolled steel is having a very quiet time also. Crown bars are unchanged at £12 per ton for home delivery, while export can be done round about £11 per ton. Pig iron is easier, hematite and No. 1 foundry being about £5 5s. per ton, and No. 3 foundry £5 per ton, all for Glasgow delivery. Only a small turnover is passing in scrap material, and the few lots disposed of are fetching poor prices.

Coal.

The coal trade continues to expand so far as export is concerned. West of Scotland round coals are not moving too quickly, but washed nuts are considerably easier, owing in a measure to the Italian demand. The Lothian collieries report good export demands for all descriptions, and heavy cargoes have gone to Germany, France and Belgium. The position in Fifeshire is much the same as in Lanarkshire, washed nuts being the chief feature. Shipments from this district are mostly in a coastwise direction. Aggregate shipments for the week amounted to 345,528 tons against 323,101 tons in the preceding week and 384,102 tons in the same week last year. The home market is most irregular, the request for industrial sorts being especially so. House coal is becoming busier as the season advances.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE has not been a great deal of change in the general conditions prevailing in the steam coal trade since I wrote a week ago, except that the market is somewhat easier. This is especially the case for spot shipment, but so far as forward business is concerned colliery salesmen are content to wait in the full expectation that stronger conditions will rule later, and that they will be able to obtain much better prices. The fact is that the international outlook is now more cheerful. It was thought at one time that the ominous situation in the Eastern Mediterranean would have the effect of stimulating the demand for steam coals. Rates of freight did certainly improve somewhat sharply, but the tone has become rather quieter all round, and there is no marked inquiry for coals. The French State Railways are reported to be in the market for about 60,000 tons of large and small coals for delivery over the remainder of the year, and the Dutch State Railways have asked for offers for about 20,000 tons, with delivery, commencing about the middle of October and extending into November. It is understood that the Norwegian Royal Navy has bought two cargoes of superior steam coals aggregating about 5000 tons for fairly prompt delivery, and there are other interesting inquiries about; but their total quantity is comparatively small, and what the collieries need especially at the moment in many instances is prompt orders, or at least prompt tonnage to lift contract coals. There is no doubt also that the settlement of the miners' strike in America, affecting as it did only the anthracite section, has had a sentimental influence on this market, for the reason that there might have been a demand in time for dry coals from this country, and this would, of course, have reacted on other grades of steam coals. Although it is early to discuss business over next year, it is interesting to note that inquiries for monthly cargoes over 1924 are circularising, these inquiries coming chiefly from Italy, but at the moment business is not materialising. Colliery companies are not prepared for the time being to come to any decision as to what they are disposed to accept for supplies so far ahead. They prefer to look on at the moment.

Extra Shift Question.

All fear that there might be trouble on the question of the working of the third shift at South Wales ports has now been disposed of by the decision of the tippers at Cardiff, Penarth and Barry to work at night during the experimental period of six months which was agreed upon. This experimental period runs up to the beginning of December, so that for two months at least there should be no nervousness as to whether the shift is to be operated. As to what may happen after that it is difficult to say.

Colliery Developments.

The directors of the Ynysfaio Colliery Company are carrying out extensive alterations and developments at their colliery at Treherbert. An area of ground has been taken for the purpose of extending the sidings and making them among the largest at South Wales collieries. An up-to-date washery is to be built, and at the present time new screens, belts, weighbridges, &c., are in course of erection to cope with the increased output.

Iron and Steel Trade.

Although the conditions in the iron and steel trade are on the whole quiet, the position of works in the Monmouthshire section of this district is fairly satisfactory. The Ebbw Vale Company has an order for 1250 tons of steel trough sleepers for the construction of a railway at Kilindini in East Africa. These sleepers are being shipped by the Union Castle liner Carlow Castle. The company has started an additional blast-furnace. Orders for black plates are being carried out by J. Lysaghts to be sent to Japan.

Current Business.

Steam coal prices are very erratic for prompt shipment. The position is that many collieries are in need of prompt tonnage, and they are prepared to cut their quotations a shilling per ton or more if they can in this way secure the immediate shipment of their coals and thus save their pits being stopped working. Although best Admiralty large are nominally 29s. to 30s., it is possible to obtain prompt supplies at less, and this applies to almost all grades, with the possible exception of dry coals, which are well stemmed. Smalls are also very irregular. Anthracite coals have lost some of their firmness, although most collieries are fairly well off for orders; but now that there is not to be a strike of the American anthracite miners an easier tone is imparted to the market. The patent fuel trade is also on the quiet side, and the general demand for coke is not so active.

Colliery Acquisition.

Reports are persistent that the Powell Duffryn Steam Coal Company, Limited, is acquiring the property of Nixon's Navigation Company, Limited, situated in the Aberdare and Merthyr Valleys, with an annual output of close on 2,000,000 tons and employing about 8500 men. So far the report is not confirmed.

Tin-plate Prices Minimum.

The Prices Stabilisation Committee meeting at Swansea on Tuesday decided to make no change in the prices of tin-plate or tin-plate bars, which will therefore rule at 23s. 1½d. basis I.C. f.o.b. minimum for the former, and £9 2s. 6d. per ton, less 7s. 6d. rebate to the tin works, for the latter for the next three months.

Manchester University Department of Metallurgy.

ON Tuesday evening, September 11th, Sir George T. Beilby, F.R.S., formally opened the new building of the Department of Metallurgy at the Manchester University. The Department is housed in a block which until recently was used for other purposes. Little structural alteration has been necessary to transform the building into one suitable for its new purpose. The additions which have been made provide four small rooms for research and separate rooms for all the main branches of work. The laboratories include those for chemical analysis, fuel, pyrometry, mechanical testing, heat treatment and metallography, including photomicrography. In addition there are a small foundry, lecture room, two private rooms for the staff and a small machinery room. The new department will be found to be well equipped for both teaching and research, and although the apparatus in the testing laboratory is all on a small scale, the University engineering laboratories are provided with larger appliances, to which metallurgical students have full access. The equipment to be found in the laboratories includes a 6000 lb. Avery tensile testing machine, a Stanton alternating stress machine, a Brinell scleroscope and Herbert small-ball Brinell hardness apparatus, and wire torsion and bending machines. The metallurgical laboratories contain metallurgical microscopes by Beck, photomicrographic apparatus by Zeiss and Reichert, with a modified Pointolite illumination and a petrological stand by Ross. In addition, there are the usual polishing and dark-room facilities. The foundry contains injector furnaces by Fletcher-Russell, assay furnaces by Morgan, and a high-temperature furnace on the surface combustion principle by British Furnaces, Limited, designed for high-temperature work in general and specially for the testing of refractory materials. A small wire-drawing machine and rolls are also available in this room. The pyrometry room includes thermo couples with potentiometers and a modified Wanner optical pyrometer. General apparatus for physical measurements, such as that of low resistance by means of the Kelvin bridge, are housed in the different research rooms. It is intended to add to the equipment in the near future an accurate dilatometer and apparatus for magnetic measurements. The co-operation which existed between the Department and that of chemistry in the time of Professor Dixon has been maintained by Professor Lapwith, who has made valuable gifts in the form of furnace models and the extensive metallurgical collection made by Forbes.

The staff comprises Professor F. C. Thompson, B.Sc., London, with Messrs. W. Cartwright, M.Sc., and H. O. Neill, M.Met., assistant lecturers. The new buildings will provide accommodation for advanced teaching and research for thirty to thirty-five students and some eight or ten research men. A departmental library has been started, to which Sir Christopher Needham, B.A., has made a valuable contribution, but further gifts are needed. Further, to consolidate the financial position, a general endowment is required and financial assistance for research purposes. Scholarships, both entrance and post-graduate, are also needed, as at the present time there are none specially allotted to the Department. The continued growth of the Department, an indication of an increasing belief in its utility, has rendered the financial position one of ever-increasing urgency, and an appeal is made to the generosity of metallurgical and engineering firms in the neighbourhood to provide these essential requirements.

LAUNCHES AND TRIAL TRIPS.

MINNEWASKA, passenger liner; built by Harland and Wolff, Limited; to the order of the Atlantic Transport Company, Limited; dimensions, 625ft. by 80ft. by 53ft. 6in.; 21,400 gross tonnage. Engines, two shaft arrangement of Brown-Curtis geared turbines, pressure 215 lb.; constructed by the builders; trial trip, August 25th.

BERWINDMOOR, steamer; built by Workman, Clark and Co., to the order of the Berwindmoor Steamship Company; dimensions, 435ft. by 56ft. by 38ft. 6in.; 10,000 tons deadweight. Engines, triple-expansion, 27½in., 45½in. and 76in. by 54in. stroke; constructed by the builders; trial trip, September 5th

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 5 0	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	4 19 6	4 19 6
Cleveland—		
No. 1	5 3 6	5 3 6
Silicious Iron	5 3 6	5 3 6
No. 3 G.M.B.	4 17 6	4 17 6
No. 4 Foundry	4 12 6	4 12 6
No. 4 Forge	4 10 0	4 10 0
Mottled	4 10 0	4 10 0
White	4 10 0	4 10 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge*	—	—
„ „ Foundry	4 15 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 10 0 to 4 12 6	
„ Forge	4 2 6	—
(3) Derbyshire—		
No. 3 Foundry	4 12 6 to 4 13 6	
Forge	4 0 0 to 4 5 0	
(3) Lincolnshire—		
Basic	4 13 0	—
No. 3 Foundry	4 14 0	—
No. 4 Forge	4 12 0	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 12 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	15 10 0	—
MIDLANDS—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	12 10 0 to 12 12 6	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ¾in. and up	10 0 0	—
Sections	9 15 0	—
Steel Sheets, 3/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 15 0	—
Angles	9 5 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	12 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0†	—
Light „	11 0 0†	—
Billets	8 0 0†	—
MANCHESTER—		
Bars (Round)	10 5 0 to 10 10 0	
„ (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 5 0	—
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	12 0 0	—
MIDLANDS—		
Small Rolled Bars	9 10 0 to 9 15 0	
Billets and Sheet-bars	7 15 0 to 8 5 0	
Gas Tube Strip	10 10 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 15 0 to 19 0 0	
Angles	9 10 0	—
Joists	9 10 0	—
Toes	10 10 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/1½ to 23/3
Block Tin (cash)	198 10 0
„ (three months)	199 12 6
Copper (cash)	63 15 0
„ (three months)	64 7 6
Spanish Lead (cash)	25 5 0
„ (three months)	25 0 0
Spelter (cash)	33 12 6
„ (three months)	32 17 6
MANCHESTER—	
Copper, Best Selected Ingots	68 0 0
„ Electrolytic	69 15 0
„ Strong Sheets	96 0 0
„ Loco. Tubes	0 1 1½
Brass Loco. Tubes	0 1 0
„ Condenser	0 1 2½
Lead, English	26 15 0
„ Foreign	25 10 0

FERRO ALLOYS.

(All prices now nominal.)

Tungsten Metal Powder	1/11 per lb.
Ferro Tungsten	1/5½ per lb.

	Per Ton.	Per Unit
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£21 0 0	8/-
„ 8 p.c. to 10 p.c. „	£20 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£70 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
„ „ 75 p.c.	£20 10 0 scale 6/- per unit	
„ Vanadium	16/9 per lb.	
„ Molybdenum	9/6 per lb.	
„ Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Inland.	Export.
SCOTLAND.		
LANARKSHIRE—		
(f.o.b. Glasgow)—Steam		19/-
„ „ Ell		20/6
„ „ Splint		21/6 to 24/-
„ „ Trebles		24/6
„ „ Doubles		23/3
„ „ Singles		21/6
AYRSHIRE—		
(f.o.b. Ports)—Steam		19/-
„ „ Splint		21/6
„ „ Trebles		24/6
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		19/6 to 22/-
Screened Navigation		27/6
Trebles		25/-
Doubles		23/9
Singles		22/-
LOTHIANS—		
(f.o.b. Leith)—Best Steam		22/-
Secondary Steam		20/6
Trebles		25/6
Doubles		24/-
Singles		22/6
ENGLAND.		
(8) N.W. COAST—		
Steams		31/6
Household		46/6 to 57/6
Coke		46/-
NORTHUMBERLAND—		
Best Steams		24/- to 24/6
Second Steams		22/6 to 23/-
Steam Smalls		16/- to 17/-
Unscreened		20/6
Household		25/- to 28/-
DURHAM—		
Best Gas		24/- to 25/-
Second		22/6 to 23/6
Household		25/- to 28/-
Foundry Coke		50/- to 52/6
SHEFFIELD	Inland.	
Best Hand-picked Branch	30/6 to 32/6	—
Barnsley Best Silkstone	26/6 to 28/-	—
Derbyshire Best Brights	25/- to 27/-	—
„ „ House	22/6 to 23/6	—
„ „ Large Nuts	20/- to 21/6	—
„ „ Small „	15/- to 16/-	—
Yorkshire Hards	21/- to 23/-	—
Derbyshire „	20/- to 22/-	—
Rough Slacks	11/6 to 13/6	—
Nutty „	10/- to 12/-	—
Smalls	7/- to 9/-	—
Blast-furnace Coke (Inland)	34/- to 35/-	
„ (Export)	f.o.b. 42/- to 43/-	
CARDIFF—	(9) SOUTH WALES.*	
Steam Coals :		
Best Smokeless Large	28/ to 30/-	
Second „ „	27/ to 28/-	
Best Dry Large	29/- to 30/-	
Ordinary Dry Large	27/- to 29/-	
Best Black Vein Large	27/6 to 28/6	
Western Valley „	27/- to 28/-	
Best Eastern Valley Large	27/- to 28/-	
Ordinary „ „	25/- to 27/-	
Best Steam Smalls	19/- to 20/-	
Ordinary „	18/- to 19/-	
Washed Nuts	27/6 to 32/6	
No. 3 Rhondda Large	30/- to 31/-	
„ „ Smalls	25/- to 26/-	
No. 2 „ Large	23/- to 24/-	
„ „ Through	18/6 to 20/6	
„ „ Smalls	15/- to 16/-	
Coke (export)	42/6 to 47/6	
Patent Fuel	30/- to 33/-	
Pitwood (ex ship)	29/- to 30/-	
SWANSEA—		
Anthracite Coals :		
Best Big Vein Large	50/- to 52/6	
Seconds	40/- to 42/6	
Red Vein	32/6 to 35/-	
Machine-made Cobbles	62/6 to 65/-	
Nuts	60/- to 62/6	
Beans	45/- to 47/6	
Peas	27/6	
Breaker Duff	12/6 to 13/-	
Rubbly Culm	15/- to 16/-	
Steam Coals :		
Large	25/- to 26/-	
Seconds	22/- to 23/-	
Smalls	14/- to 16/-	
Cargo Through	20/- to 22/6	

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal. † Latest quotations available.

French Engineering Notes.

(From our Correspondent in Paris.)

Coke and Iron Ore.

THE prices of German coke are advancing with such rapidity that consumers are looking to a possible increase in the cost of iron and steel production which may seriously affect their situation in the early future. Some even affirm that the cost may become so prohibitive as to necessitate a cessation of work. There is probably a great deal of exaggeration in the statements that are being made, apparently with a view to compelling the Government to secure a reduction in the price of German coke; but, nevertheless, it is certain that the situation of consumers is becoming more and more acute, and the question of coke supplies must be rapidly solved if the iron and steel industry is not to pass through a very trying period. As the coke supplied by Germany was set off against the amount due for reparations, the price was based upon that ruling in Germany, and the coke seized in the Ruhr has to be disposed of under the same conditions, with the result that the seizure of coke in the Ruhr, by causing a scarcity of supplies in Germany, has automatically increased the price. It is therefore urged that the coke should not be sold at what is really an abnormal price fixed by the Germans themselves. Efforts are being made to induce the French Government to modify the conditions under which coke is supplied to consumers. At the same time, there are many rumours of tentative negotiations on the part of German producers with a view to coming to an arrangement with the French on the basis of an exchange of coke for Lorraine iron ore.

Foreign Contracts.

Despite the increasingly high prices of raw material, a good deal of foreign business is being done by some of the leading engineering concerns, not only in Czecho-Slovakia and other European countries, where a considerable amount of French capital is employed, but also in markets where British firms would appear to have a particular advantage. Fives-Lille has secured a contract for the installation of a sugar factory in India, as well as for a bridge in Egypt, which, I understand, will be upon a principle similar to that of the Tower Bridge in London. Although the French bridges show marked originality in design, engineers here follow closely every new development of British bridge-building practice, and have made frequent visits to England to inspect new bridges, with the result that in certain cases they have not hesitated to adopt essentially British features. If, however, a fair number of good contracts are being secured from the Old World, very little is being done with South American and other markets, which were valuable customers of French engineering concerns before the war. Great efforts are being made to recover this trade, but so far, despite the apparent advantage of the exchange rate, they have not met with any conspicuous success.

Power Alcohol.

The law which was passed six months ago requiring importers of petrol and other oils for fuel to purchase from the State a quantity of power alcohol equal to 10 per cent. of the quantity of oil imported the previous month has now come into operation. A licence has to be obtained to import oils, and its continuance depends upon the monthly purchase of alcohol. The law was passed to ensure the absorption of alcohol made from grain and beetroot, which is a monopoly of the State, with the idea of cheapening the spirit for industrial purposes and replacing, as far as possible imported petrol; but until some really commercial process of dehydrating alcohol is introduced, it is doubtful whether the State can enforce a mixture which is generally recognised as inferior to petrol, although an equal mixture of alcohol and petrol gives quite satisfactory results. The future of alcohol lies more particularly in its cost, and at present it can only be sold cheaply at the expense of the ratepayers. The new law is an attempt to enforce the use of a home-distilled spirit with a view to the ultimate employment of a "national fuel," and the effort of the State to compel consumers to use a product of which it has a monopoly will be watched with interest.

Helicopters.

The practical results so far obtained with helicopters are very small compared with the heavy expenditure that has been made upon experimental and research work during the past few years, largely with subsidies provided by the State, which considers that this type of machine, if developed along suitable lines, is likely to have a wide field of utility. A good deal of hope was centred in the Pescarra helicopter, which has made several attempts to secure the prize offered for a machine making a complete circuit and returning to its starting point. Every attempt failed, and last week the machine, after travelling about 100 m., dropped to the ground with such force that it was hopelessly damaged. M. Pescarra states that he will continue his tests with another helicopter that is nearly completed. Meanwhile, other experimenters are building helicopters, and are intending to use much more powerful engines with huge propellers, from which it would appear that efforts are now being made to work out the problem along new lines.

Iron and Steel Output.

The returns of iron and steel production show that there were 107 furnaces in blast in France on August 1st, as compared with 116 on January 1st. The quantity of pig iron produced during July was 436,420 tons, showing a decline of 10,593 tons on the previous month and of 76,868 tons as compared with the last normal output in December. There was also a diminution of 27,872 tons in the production of steel on the previous month, the total for July being 399,528 tons. This is the first time that a falling off has been observable in the iron and steel output since the Ruhr occupation in February last. It is attributed to the insufficient supplies of Ruhr coke.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

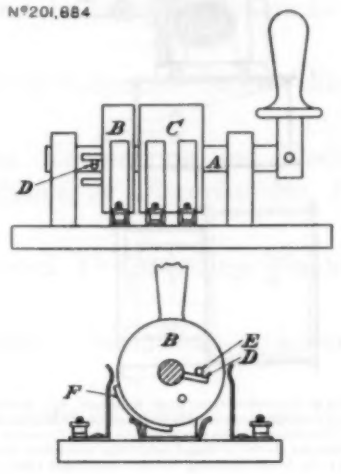
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

201,684. May 23rd, 1922.—IMPROVEMENTS IN OR RELATING TO STARTING AND CONTROLLING APPARATUS FOR ELECTRIC MOTORS, Adolph Harry Railing, Charles Cornfield Garrard, and William Wilson, all of Magnet House, Kingsway, W.C. 2.

This invention relates to starting electric motors which are controlled by magnet switches or contactors. On the spindle A of the master controller there are two drums B C carrying the moving contacts, one C being fixed to the operating spindle so as to revolve with it and being used for carrying the contact or contacts for connecting the line contactors. The other drum B, which is used to carry the contact F or contacts to connect the accelerating contactors, is mounted on the spindle A so that the

N°201,684



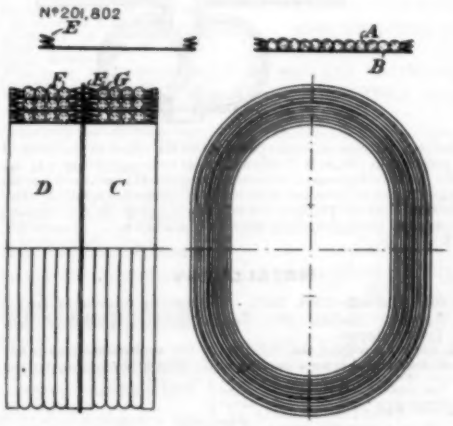
spindle may be moved towards the "off" position through a definite angle without moving the drum B until after the line contacts have been opened. The movement of this loose drum B is brought about by the engagement of projections or studs formed on or attached to the spindle or the drum. There are corresponding parts on the loose drum, as, for instance, the pin D projecting from the spindle A and pin E on the drum B, the pins engaging during the movement to the "off" position. When the handle is moved to the "off" position the line contacts are first opened before the loose drum is moved, with the result that the current is ruptured only on the line contactors.—*August 9th*, 1923.

TRANSFORMERS AND CONVERTERS.

201,802. September 20th, 1922.—IMPROVEMENTS IN METHODS FOR INSULATING THE COILS OF STATIC TRANSFORMERS, Victor Eugène Sostene, of 15, Avenue Matignon, Paris.

The method of insulating the coils of transformers in accordance with this invention will readily be understood from the drawing. Between the layers of wire A there is a paper strip B

N°201,802

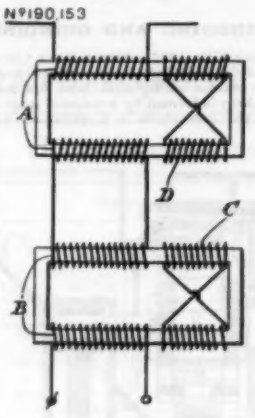


and between the coils C and D there are folded portions E of the strip. The distance between the adjacent wires F G of the coils is thus twice the width of one of the folded portions E of the paper. To provide for suitable insulation between the coils it is therefore sufficient to vary the width of the folded portions according to circumstances.—*August 9th*, 1923.

190,153. December 6th, 1922.—IMPROVEMENTS IN AND RELATING TO HIGH-TENSION ELECTRIC TRANSFORMERS, Emil Pfiffner, of 15, Bahnhofstrasse, Mels, b/St. Gallen, Switzerland.

This invention relates to high-tension transformers of the kind in which use is made of series-connected elements, each of which comprises an iron core insulated from earth and two windings insulated from the iron core. The windings are mounted separately as shown and the stray fields produced are destroyed by a short-circuited winding. The transformer consists of two elements having the iron cores, which are connected in cascade electro-magnetically by the windings A B. For preventing stray fields the compensating windings C and D are provided, which have the same or approximately the same number of turns. In the drawing, for the sake of clearness, the compensating windings are shown next to the other windings. In reality, however,

N°190,153



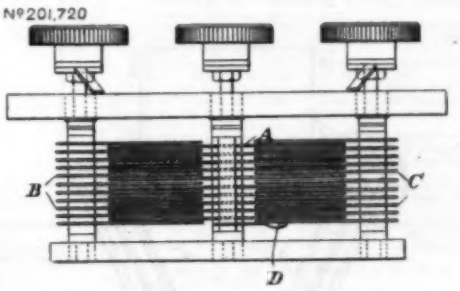
the compensating windings are placed coaxially over the main windings, so as to take up the stray fields of the latter as perfectly as possible.—*August 9th*, 1923.

TELEGRAPHS AND TELEPHONES.

201,720. June 27th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL VARIABLE CONDENSERS, Albert Edward Chapman, of 90, Bramshot-avenue, Charlton, S.E. 7.

The object of this invention is to provide a variable condenser capable of being connected to, or of forming part of two or more interconnected circuits, for instance, the aerial circuit of a wireless station and a closed oscillatory circuit coupled therewith, in order to vary the capacities of the circuits, or for any other purpose, such as for serving as a combined variable grid condenser and static reactance coupling, &c. Three movable groups of sector-shaped plates A, B and C, each convering an angle of about 120 deg., are assembled around a common axis, each group being mounted on a spindle and being provided with

N°201,720



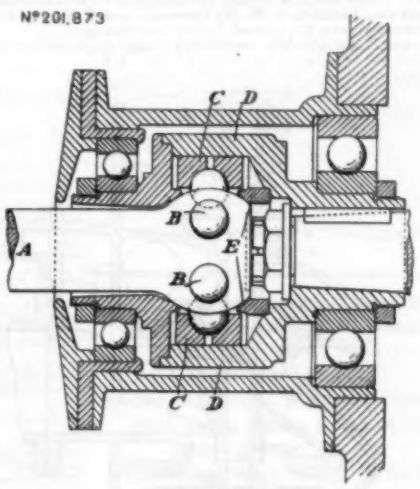
an operating knob. By means of these knobs the plates of each group can be turned between the plates of the other groups. Each one of these groups is electrically connected to a terminal, and the spindle of the group A carries a spring-contact arm D adapted to make contact, when the group A reaches a certain point during its movement, with one of the plates of the group C with which it forms a series condenser and to maintain the short-circuiting connection of the series condenser during the time the group A is used as a parallel condenser with respect to the other group B. Preferably the group A is moved through an angle of about 10 deg. after maximum series capacity is reached before the short-circuit referred to takes place.—*August 9th*, 1923.

TRANSMISSION OF POWER.

201,873. August 19th, 1919.—UNIVERSAL JOINTS, H. C. Clark and A. H. Huddart, 1, Grosvenor-place, Hyde Park Corner, London, S.W. 1.

In this universal joint the spherical end of the shaft A is provided with balls B seated in hemispherical recesses. These balls work in conjunction with cylindrical slippers C. The slippers are carried by the outer member D, which is formed by boring a

N°201,873



number of equidistant holes parallel with the axis of rotation and having their centres arranged on a pitch circle, the diameter of which is equal to the diameter of the hemispherical end of the shaft. The centre part of the outer member is then bored out to the diameter of this pitch circle in order to receive freely the spherical end of the shaft, and the slipper members, which may be formed of phosphor-bronze, are adapted to slide freely in the apertures formed in the outer part of the joint. When it is

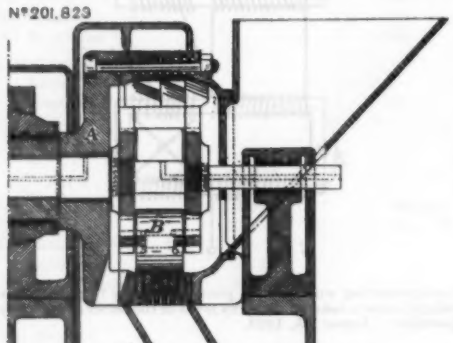
desired that no telescopic movement shall be permitted to the joint, end plates E may be fitted having spherically formed surfaces adapted to engage the spherical enlargement upon the shaft.—*July 5th*, 1920.

CRUSHING AND GRINDING.

201,823. October 27th, 1922.—SUGAR CANE CRUSHING, *Duncan Stewart and Co., Limited, London-road Ironworks, Glasgow.*

In this sugar cane crushing mill there is a rotary cage A of which the periphery is formed by a series of rings spaced slightly apart. Inside the cage there is a spider on which there are

N°201,823.

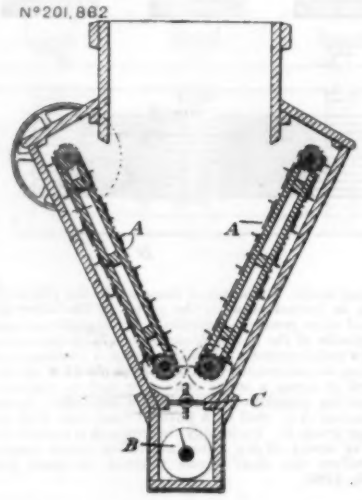


mounted several crushing rolls B. The cage and the spider are driven at speeds differing by about 5 per cent., so that while the full centrifugal crushing effect is maintained, the rollers progress round the cage only slowly. Ploughs are provided for feeding the cane forwards toward the outlet C.—*August 9th*, 1923.

201,862. February 20th, 1923.—MACHINES FOR MIXING GRANULAR SUBSTANCES, G. Porteus, Leeds Bridge Works, Hunslet-lane, Leeds.

In this apparatus the granular material is fed into a V-shaped hopper, on each side of which there is a band conveyor A. At

N°201,862.



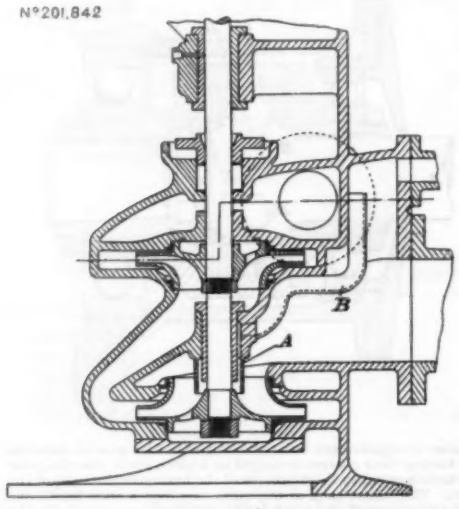
the bottom there is a discharge worm B, while a damper C is arranged in the throat. By changing the direction of travel of the conveyors and adjusting the damper the material can be continuously mixed, mixed and discharged, or discharged without mixing.—*August 9th*, 1923.

PUMPING AND BLOWING MACHINERY.

201,842. December 21st, 1922.—CENTRIFUGAL PUMPS, Drysdale and Co., Limited, J. W. W. Drysdale, and J. Young, Bon Accord Works, Ferry-road, Yoker, near Glasgow.

This invention relates to centrifugal pumps employed for the

N°201,842.



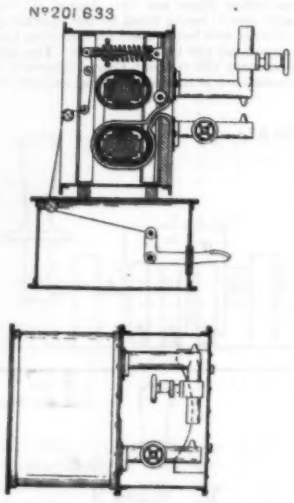
withdrawal of liquid from vessels under high vacua, such as condensers. For satisfactory working it is necessary to secure freedom from air leakage at the glands, a self-clearing action of air locks, and the maintenance of a head of water over the impeller eye. The pump is thus arranged to rotate on a vertical shaft. It is of the two-stage type, i.e., with two impellers in series. The first-stage impeller is disposed at the lowest point in the pump and is so arranged that the water from the vessel which is being drained tends to gravitate into the eye of this impeller. The water passages of the pump are so disposed as to prevent the formation of air locks by the flow in them being always upwards from the first-stage impeller to the final discharge outlet of the pump. An essential feature is the provision of a chamber A situated above the first-stage impeller and in communication with the eye of this impeller, and connected by means of a balance pipe B with the vessel which is being drained, the intention being that air drawn in by the liquid shall be caught in the chamber and drawn back by the air pump.—*August 9th*, 1923.

MACHINE TOOLS AND SHOP APPLIANCES.

201,633. May 2nd, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRIC WELDING OR HEATING MACHINES, Edmund Schröder, of 48–51, Maybach-Ufer, Berlin S.O. 36, Germany.

The object of this invention is to facilitate the transport of electric welding or heating machines by utilising the frame of the machine itself as a container for the working parts. The parts

N°201,633.



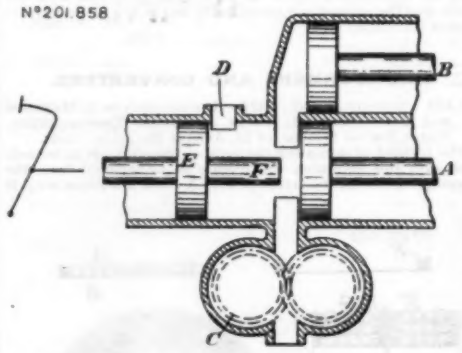
can therefore be protected from dust, moisture, &c., without the use of special packing cases or other expensive packing materials. The upper illustration shows the machine ready for work, whilst the lower drawing shows it closed ready for transport, the right-hand part of the lower drawing being a sectional view.—*April 2nd*, 1923.

MOTOR CARS AND ROAD TRAFFIC.

201,858. February 1st, 1923.—BRAKE GEAR, D. Napier and Son, Limited, and G. S. Wilkinson, 211, Acton-vale, London, W. 3.

The two pistons A and B are connected with the rear and front brakes, respectively, of the vehicle. The gear pump C, which is driven by the back axle, and thus only works when the vehicle is

N°201,858.



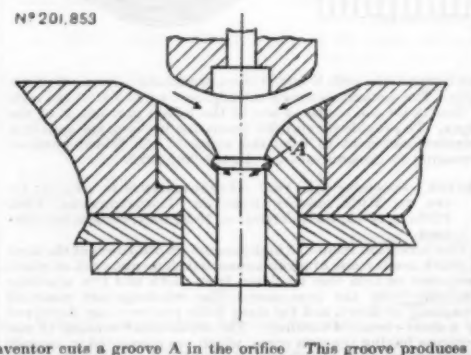
in motion, delivers oil under pressure to the space at the back of the piston, but the port D allows the oil to escape freely. If the brake pedal is depressed, however, the port D is covered by the plunger E, the oil pressure rises and the brakes are applied. The extension F on the plunger can be used to apply the rear brakes, by means of the pedal, if the oil supply should fail.—*August 9th*, 1923.

METALLURGY.

201,853. January 23rd, 1923.—NOZZLES OF CASTING LADLES, Ryosaku Godai, 99, Takehayachio, Koishikawa-Ku, Tokyo, Japan.

In order to reduce the velocity of the molten steel or other metal discharged from a casting ladle with a bottom outlet the

N°201,853.



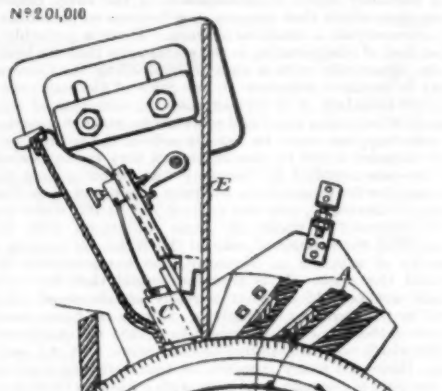
inventor cuts a groove A in the orifice. This groove produces eddies in the jet of metal, which, by absorbing energy, reduce its velocity.—*August 9th*, 1923.

DYNAMOS AND MOTORS.

201,010. June 30th, 1926.—IMPROVEMENTS IN AND RELATING TO DYNAMO ELECTRIC MACHINES, *The British Thomson-Houston Company, Limited, of Crown House, Aldwych, W.C. 2.*

This specification describes a new form of arc barrier for preventing the spreading of arcs on direct current machines, such as rotary converters. The arc barriers are shown at A, and they act as scoop and lift, the arc occurring under the

N°201,010.



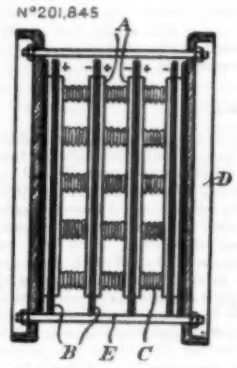
brushes C from the commutator. Metal members D are mounted on the front surface of one more of the insulating barriers A, and these metal members absorb some of the heat of the arc. The member E, which is called an arc splitter, splits up the arc and prevents it crowding to the end of the commutator.—*July 19th*, 1923.

MISCELLANEOUS.

201,845. December 27th, 1922.—IMPROVEMENTS IN ELECTRICAL CONDENSERS, Walter Dornig, of 37, Fregestrasse, Berlin-Steglitz, Germany.

The condenser described in this specification is built up of smooth metal plates A and plates B of insulation sandwiched between them. These sets of plates are separated by spacing members C, which are grooved in order to lengthen the path for sneak currents or discharges. The packet of plates is firmly held

N°201,845.



together by outside plates D with the aid of tension rods E. The lower tension rods E may also serve as supports for the insulation plates B. In this form of condenser the cooling is effected by the surrounding air or by an air current blown through the condenser by means of a fan. The positive and negative signs indicate that the metal plates are alternately connected to the positive or negative terminals.—*April 9th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

WEDNESDAY TO WEDNESDAY, SEPTEMBER 12TH TO 19TH.

BRITISH ASSOCIATION.—Meeting at Liverpool.

SATURDAY, SEPTEMBER 15TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting at Cheltenham. 10.30 a.m.

MONDAY AND TUESDAY, SEPTEMBER 17TH AND 18TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Milan.

MONDAY, SEPTEMBER 17TH, TO WEDNESDAY, OCTOBER 3RD.

National Gas Exhibition at Bingley Hall, Birmingham.

THURSDAY, SEPTEMBER 20TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. "Heavy Tonnage Handling on Railways of the United States," by Mr. R. P. C. Sanderson. 7 p.m.

MONDAY, OCTOBER 1ST.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Presidential address by Sir J. G. Broodbank. 5.30 p.m.